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datron
ELECTRONICS LIMITED

SERVICING MANUAL

for

DATRON MODEL 1057a

DIGITAL MULTIMETER

METEOR CLOSE
NORWICH AIRPORT INDUSTRIAL ESTATE NORWICH NR6 6HQ ENGLAND

MP MASTER
MA23499

117

SERVICING MANUAL
for
DATRON MODEL 1057
DIGITAL MULTIMETER

(FOR GENERAL INFORMATION
AND SPECIFICATION REFER TO
OPERATING MANUAL)

Instrument Designed and Manufactured by:–

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SECTION 1

TECHNICAL DESCRIPTION

1.1 GENERAL

Internal circuitry of the 1057 comprises two main assemblies. On the Analogue Assembly the measurement function and range is selected. Any full range signal is scaled to a nominal one volt D.C. output. Logic outputs are also generated denoting the range and function selected. The Analogue to Digital Converter Assembly digitizes the analogue signal to drive the display. The regulated power supply components are also mounted on this board.

The boards are described separately; each board is sub-divided into its various functions.

1.2 ANALOGUE ASSEMBLY

1.2.1 Mechanical Layout

The Analogue Assembly consists of the following sub-assemblies:

1. The Analogue Board which carries the switch banks S.B. 1-4 and all the active measurement circuitry. This is fitted with upper and lower guard shields, totally enclosing all analogue circuitry.

2. The Switch Board which carries the high voltage and high impedance circuitry. This assembly is mounted over switch banks S.B. 2 and S.B. 4.

Electrical Layout

The complete Analogue Assembly can be divided, as shown in Fig. 1.1, into the following main circuit areas:

1. Range and Function selection switching network including an input attenuator network. This D.C. voltage attenuator is extended to accommodate A.C. by addition of frequency compensation capacitors and is also used to form a resistance converter.

2. Range and Function coding logic circuits which command the appropriate active analogue switches.

3. A D.C. isolator which is used for all measurement functions, except A.C.

4. An A.C. isolator and true r.m.s. converter, used whenever A.C. is selected.

5. The A–D converter board command and Range/Function indication circuit.

   The 15V power supply and precision 5 volt reference are generated on the A–D converter board.

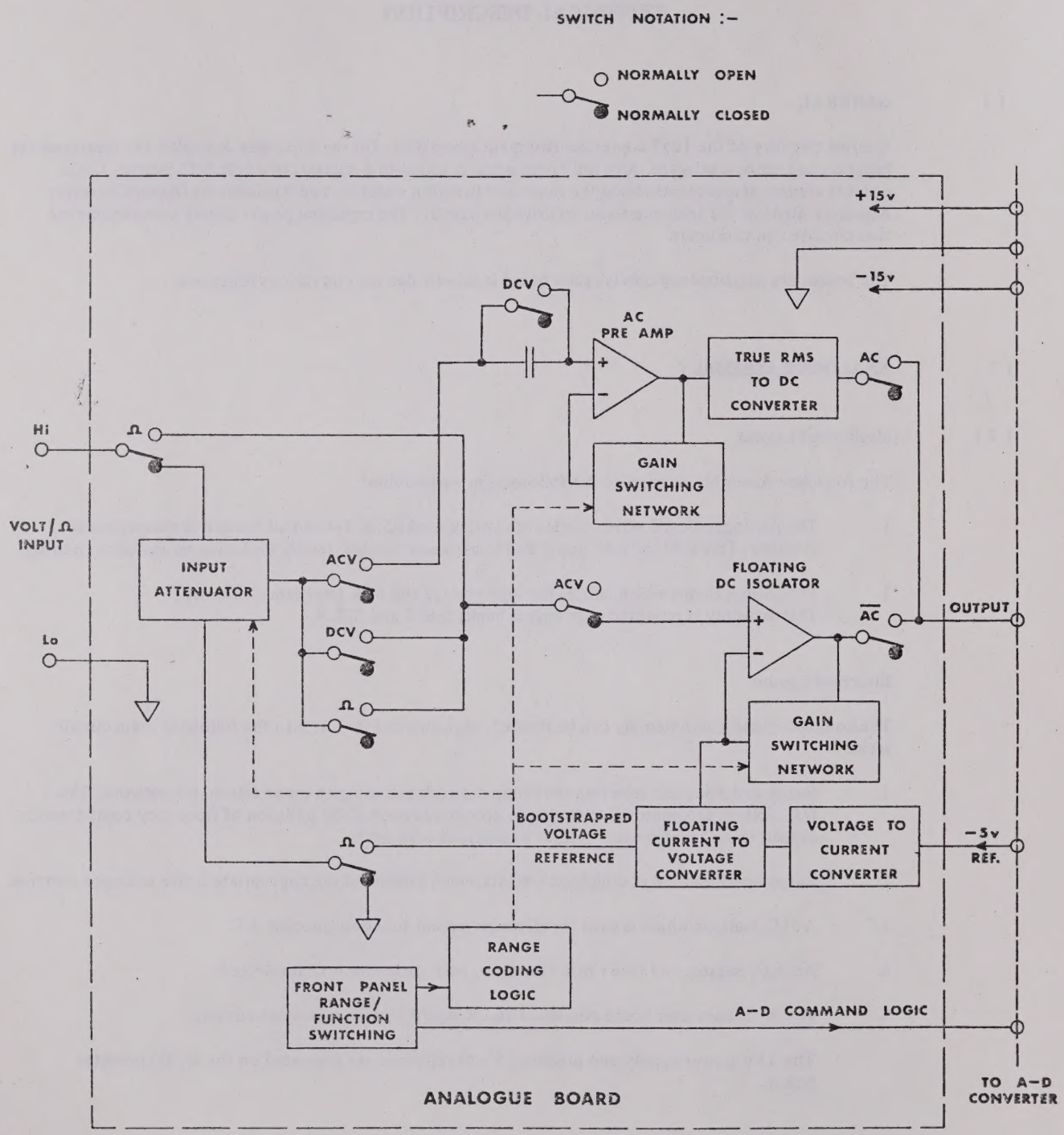


FIG 1.1 SIMPLIFIED DIAGRAM OF ANALOGUE CIRCUITS

1.2.2 DC Isolator

The DC isolator is called up by the input switching and M2/C when 100mV DC or DCV is selected. The preamplifier is designed to present an input impedance of greater than 10,000 MΩ to signals up to ±2V and exhibit a very low input bias current (typically less than 20pA).

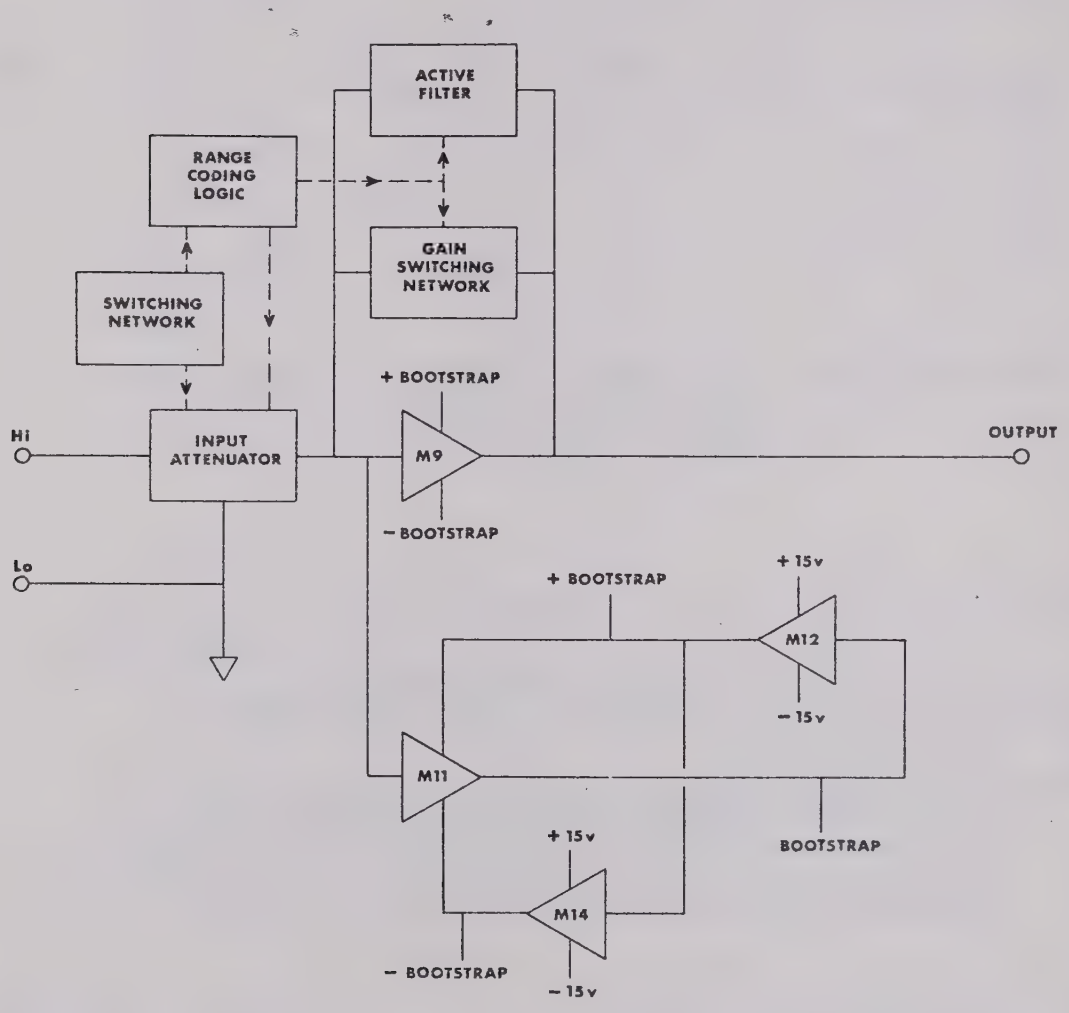


FIG 1.2 SIMPLIFIED DIAGRAM OF DC ISOLATOR

1.2.2.1 Range Switching

In the 100mV DC and the 1V DCV range the input signal is switched directly to the dc preamplifier (see Fig 1.3(a) and (b).
For the 10V, 100V and 1000DCV ranges the attenuator network A.N.1, is switched in. The network is trimmed on each range to obtain a 1V full range output to the dc preamplifier as shown in Fig 1.3(c), (d) and (e).

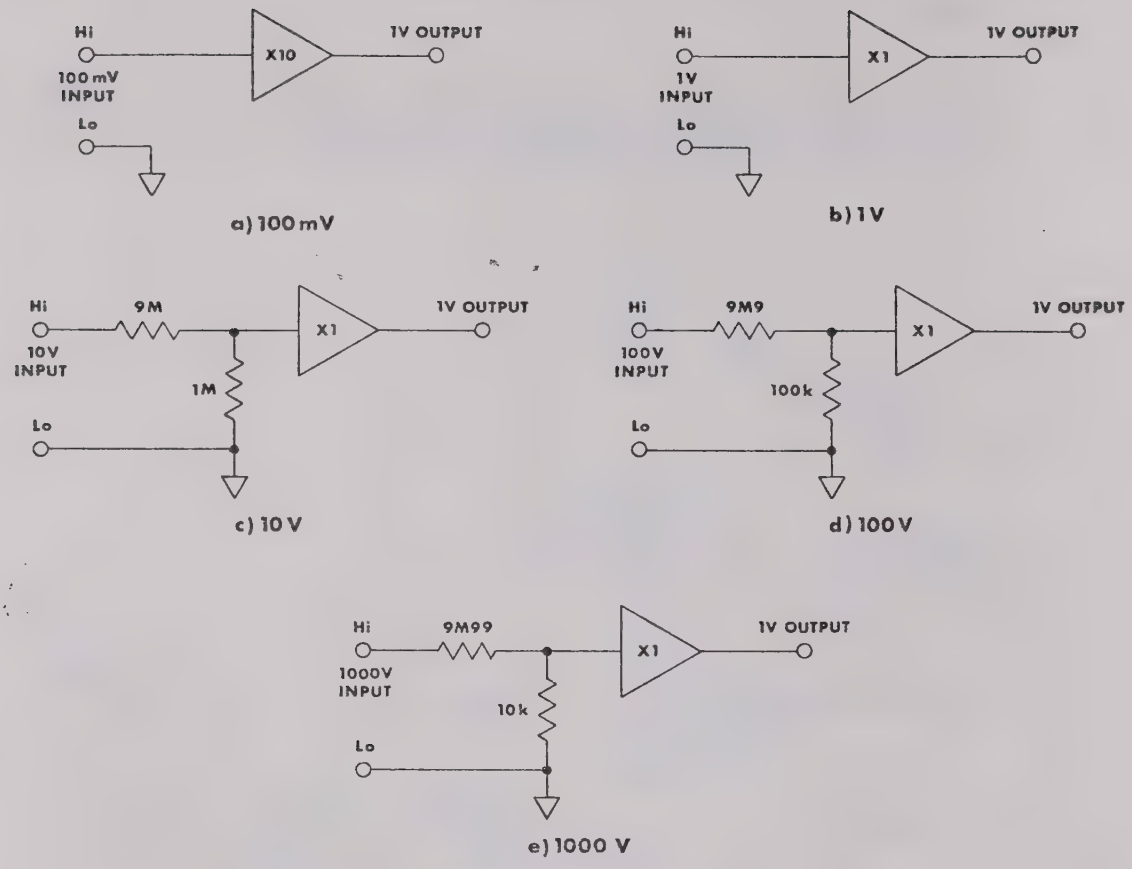


FIG 1.3 RANGE SWITCHING

1.2.2.2 Input Attenuator Trimming

The absolute values of the resistors in the attenuator are not as critical as their ratios.
The method of trimming is as follows: resistance from the output tapping to signal common (Lo) is increased by a percentage greater than the ratio percentage error, so the network always reads high. This is now brought down into calibration by a shunt path across the lower combination as shown in Fig. 1.4.

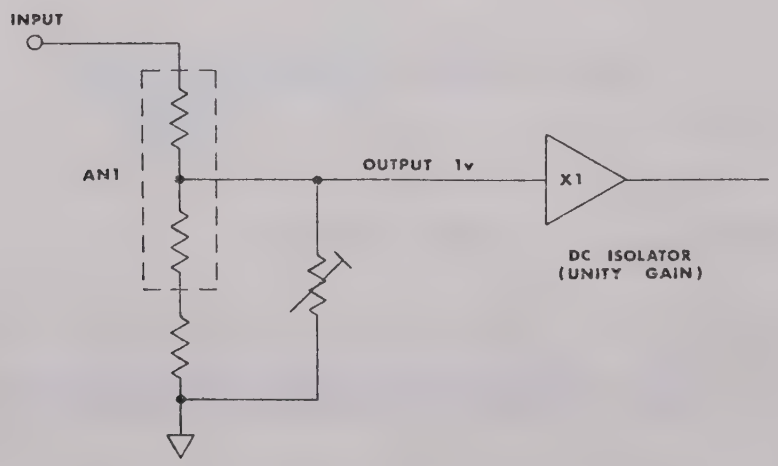


FIG 1.4 SIMPLIFIED ATTENUATOR TRIMMING

In practice it is convenient to shunt only the lowest resistance value in the attenuator network. So for each range we have the switched resistor combination shown in Fig. 1.5.

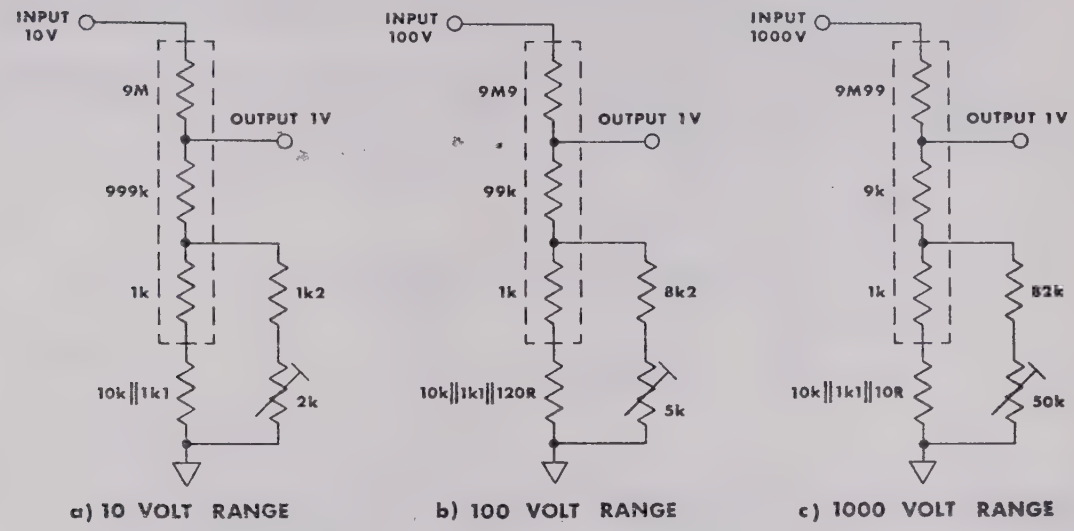


FIG 1.5 ATTENUATED RANGES

1.2.2.3 Preamplifier Scaling

The DC preamplifier has two switched gain defining networks and the simplified diagram, Fig. 1.6 shows the essential features.

1. x10. Selected in 100mV DC and 1kΩ range. M10/B is turned 'on' and the output of M9 is connected to its inverting input via a ÷ 10 attenuator. Hence the overall gain of the amplifier is 10.

2. x1. Selected in all remaining DC voltage and resistance ranges. M10/A is 'on' and the output of M9 is connected directly to its inverting input. The overall gain of the amplifier is unity.

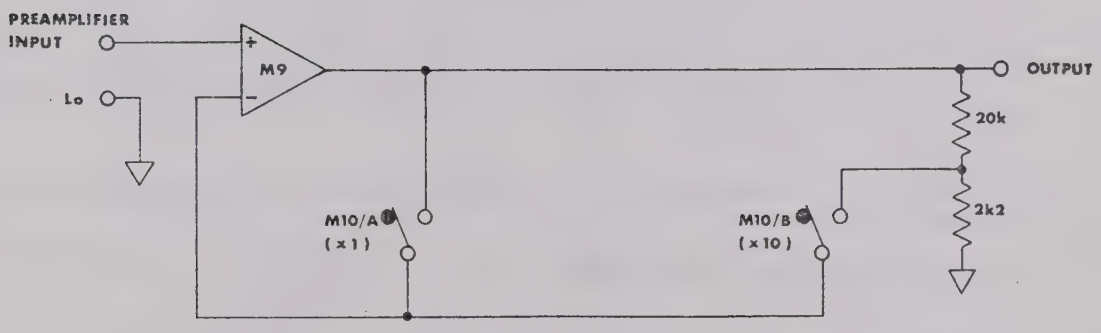


FIG 1.6 PREAMPLIFIER SCALING

1.2.2.4 Bootstrapped Supplies

Bootstrapping (the tracking of both ground lines and supply voltage with input signal) is essential for correct operation of input bias current compensation, input offset voltage compensation, temperature compensation and common mode rejection. The generation of +B.S. forms the basis of the resistance converter described in Section 1.2.4 and the addition of ½ (–B.S.) permits the use of Quad Bilateral Switches over a full switching range of –5V to +12V d.c.
M11 is a high input impedance buffer which looks at the inverting input of M9. The offset of M11 is adjusted so that its input is within 100μV on the input of M9 (the signal). M11 thus functions as a low impedance rail following the input signal.

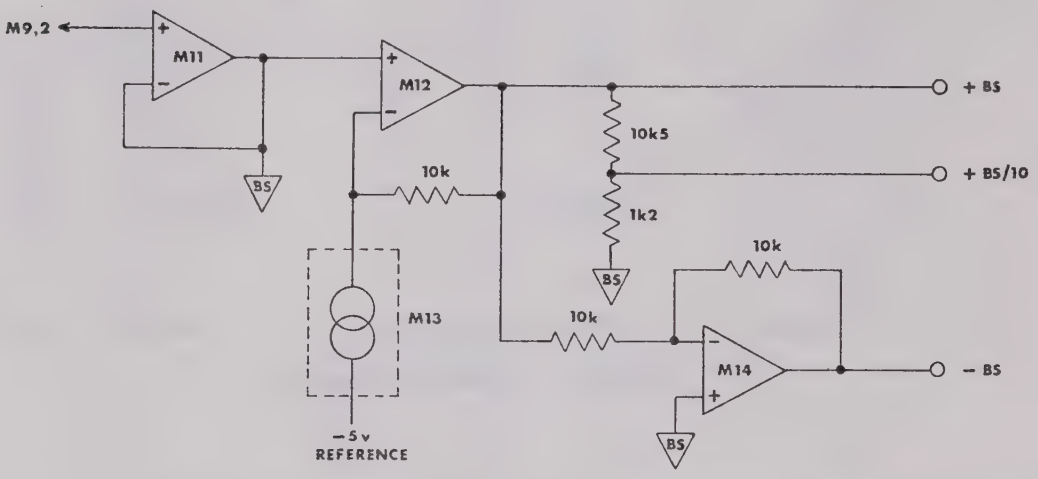


FIG 1.7 GENERATION OF BOOTSTRAPPED SUPPLIES

A voltage to current converter comprising M13 uses the –5V reference generated on the A–D board to produce a constant current of 1mA. Therefore 1mA must flow through the 10kΩ feedback resistor, R79, from the output of M12 and so 10V will be developed across the 10kΩ resistor. Since the non-inverting input of M12 is referred to bootstrap, the output of M12 will remain at +10V (+B.S.) with respect to the bootstrapped input signal. The –10V supply (–B.S.) is readily obtained by inverting +B.S. with respect to B.S. These power supply rails power the preamplifier, M9 and the bootstrap amplifier, M11. So, for example, with a +1V signal input on the high terminal the positive supply to M9 is +11V and the negative supply is –9V. Thus excellent common mode rejection is achieved.

1.2.2.5 Drift Compensation

M9 is a device selected by Datron which undergoes a long high temperature 'burn-in' on power. The device exhibits a nominal voltage drift of $\pm$ 5 μV/^{o}C and a typical bias current of 1ηA. Q9 is kept in close thermal contact with M9 and the whole input stage is under a draught excluding plastic moulding. Q9 has a base emitter voltage which changes at the same rate with temperature as the bias current of M9. Consequently a current derived from Q9 base emitter and fed into M9 input compensates for the bias current. Tracking to $\pm$ 2pA/^{o}C is achieved in this way.

To compensate for voltage drift, the actual drift is first measured and a correcting offset then injected to reduce that drift.

The final drift is $<$2 μV/^{o}C from 0 to 50^{o}C.

1.2.2.6 Filtering

A 2 pole active filter provides 30dB of attenuation at 50Hz increasing at 50dB/decade, and settles to 0.01% in 650mS. An additional 50dB of attenuation at 50Hz is obtained in the A–D circuitry by using a 20mS integration period (see Section 1.3.2.5).

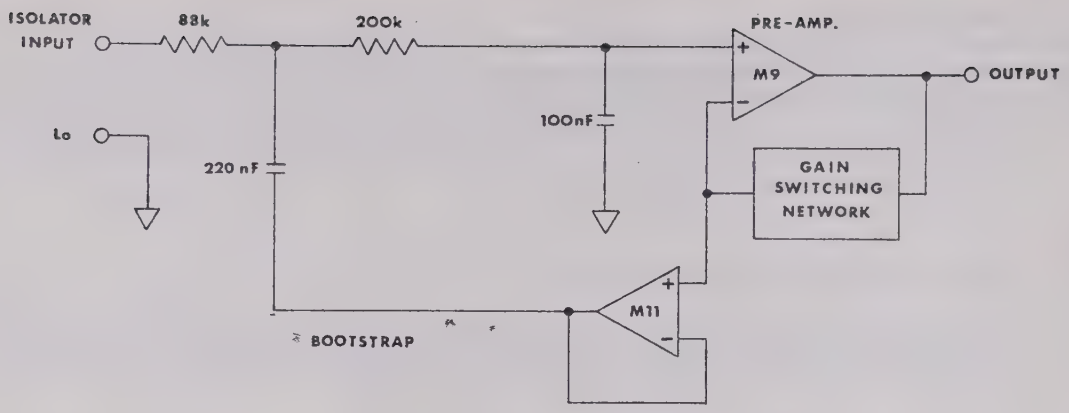


FIG 1.8 FILTER NETWORK

1.2.2.7 **Input Protection**

Resistor chain R30–33 (88kΩ total) is in series with the Hi input to the dc preamplifier. The preamplifier end of R33 is clamped by F.E.T.s Q6 and Q7 to the bootstrapped rail, which is in turn clamped to Lo (0v) by zener diodes D20 and D21. The 88kΩ chain limits the current in overloads and so the input to the preamplifier is clamped to approximately ± 4.5V. The power dissipation of the chain is such that 1000V may be applied continuously.

1.2.3 **AC Converter**

The AC Converter consisting of the ac isolator and true r.m.s. converter is called up by the input switching and M2/D when ACV or DCV + ACV is selected. The latter, dc coupled mode, computing the r.m.s. value of the dc and ac component of the input signal.

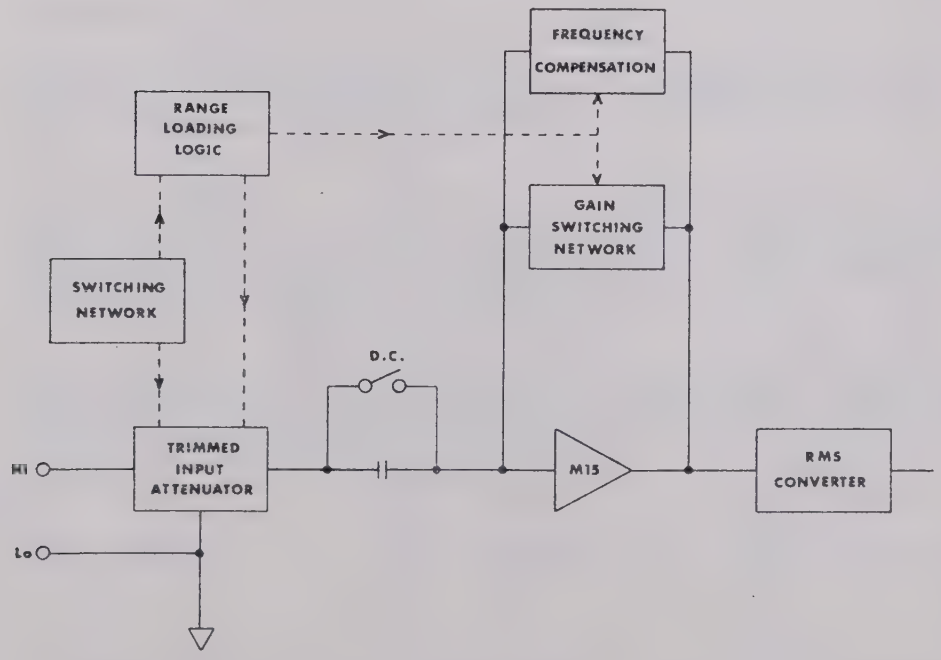


FIG 1.9 SIMPLIFIED DIAGRAM OF AC CONVERTER

1.2.3.1 Range Switching

In the 1V ACV range the input signal is switched directly to the ac preamplifier which has unity gain. For the 10V, 100V and 1000V ACV ranges the attenuator network A.N.1 is used as described in section 1.2.2.1. Thus excellent dc performance is available in the dc coupled (DCV + ACV) mode. The network is frequency compensated to maintain accuracy at higher frequencies by addition of capacitors across each voltage tapping as described in section 1.2.3.2.

1.2.3.2 Input Attenuator Frequency Compensation

The input attenuator network is trimmed for ac high frequency signals by the addition of decoupling capacitors between the network tappings. Values are chosen so that the same time constant appears between all tappings as shown in Fig. 1.10 where R1.C1 = R2.C2.

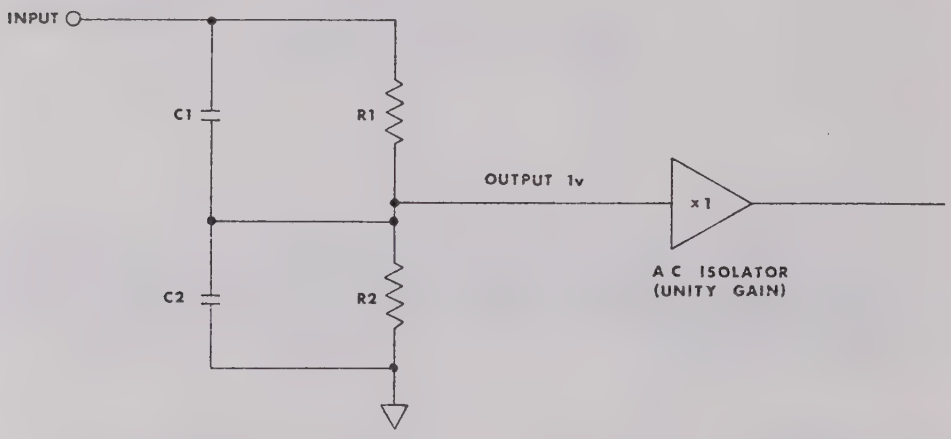


FIG 1.10 SIMPLIFIED ATTENUATOR H. F. TRIMMING

To considerably simplify the switching the method of trimming each range is a compromise to the ideal and does make each adjustment reasonably independent of the other trimmer settings (see Fig. 1.11).

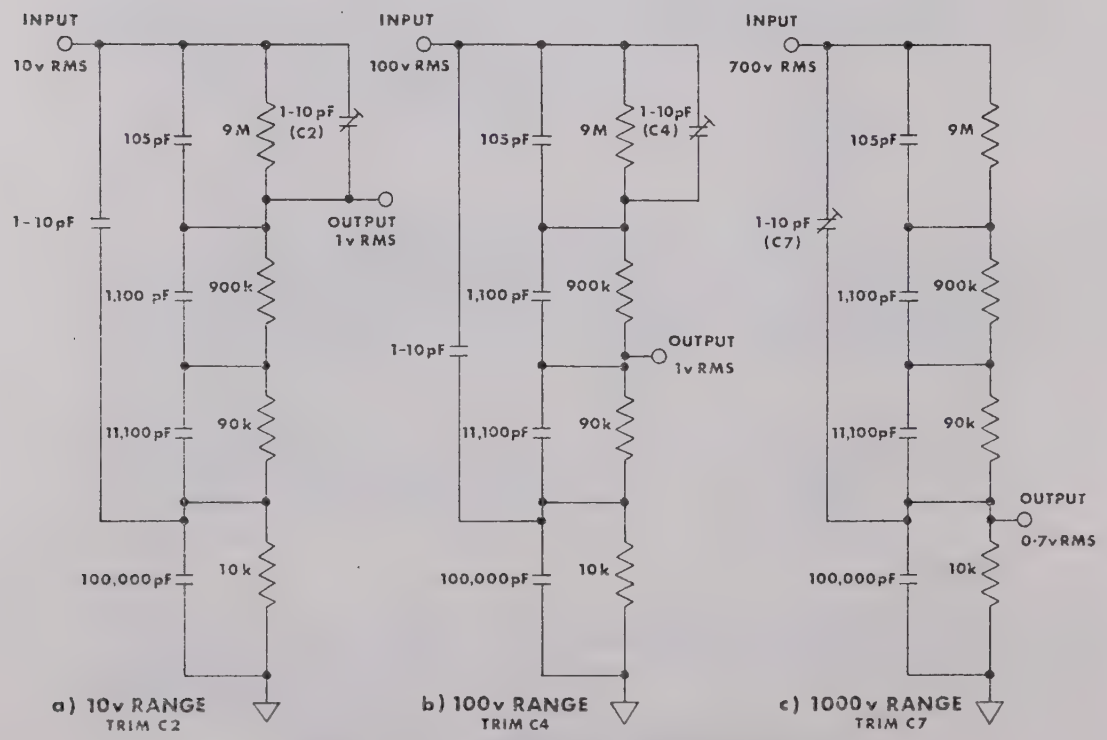


FIG 1.11 ATTENUATED AC RANGES

In practice the decoupling capacitor across the 9MΩ is split into two separate components C1 and C2 to share the voltage. Similarly, the voltage across the trimmers C2, C4 and C7 is reduced by series capacitors C31, C30 and C60. Capacitors C57 and C58 help compensate in the 10V range for the small, but finite, stray capacitance from the ac isolator input to ground.

1.2.3.3 Preamplifier scaling

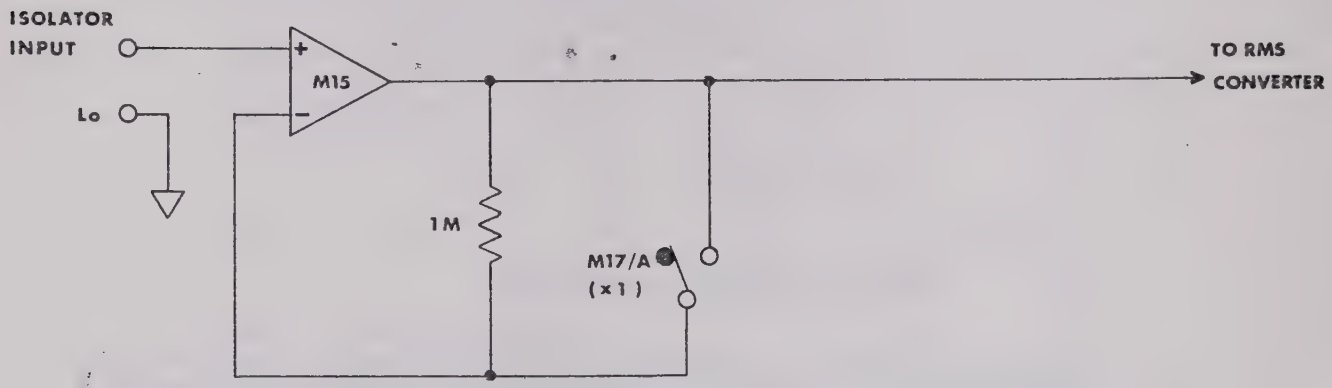


FIG 1.12 AC PREAMPLIFIER SCALING

x1. Selected for all ac voltage ranges. M17/A is 'on' and the output of M15 is connected directly to its inverting input. The overall gain of the amplifier is unity.

The gain is only approximate since the preamplifier also has gain to its own offset control and via M17/D.

When x10 is called up for dc measurements, M17/A will be 'off' and so the loop is closed by the 1MΩ resistor, R111.

1.2.3.4 Preamplifier

The input to the preamplifier may be either ac or dc coupled. In dc coupled operation the dc blocking capacitor, C32 is bridged by closing the DCV switch pole. The maximum discharge current from C32 through the switch poles is limited by resistors R21 and R22.

In ac coupled operation the dc blocking capacitor, C32, interrupts the bias current of the preamplifier, M15, and so an alternative path is provided via R94, R95 and M17/B ('on' in ac coupled). By driving the junction of R94/R95 via C33 from the bootstrapped supply, M16, it is possible to still maintain the high input impedance (>1000MΩ) over the specified frequency range.

Resistor chain R90–R93, 88kΩ total, is in series with the input to M15. The amplifier end of R93 is clamped via F.E.T.s, Q14 and Q15 to the ac bootstrapped input signal, which is in turn clamped to Lo (0V) via zener diodes D1 and D2. The 88kΩ chain limits the current in overloads and the power dissipation of the chain is such that 1000V pk may be applied continuously.

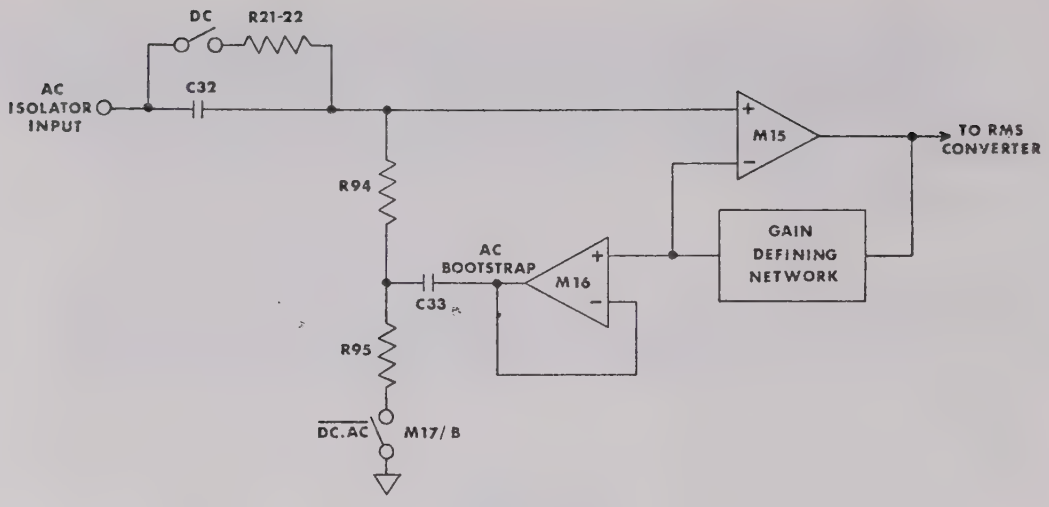


FIG 1.13 AC COUPLED OPERATION

The high frequency response is set by adjusting C40 which, with R110, presents a time constant at the inverting input of M15 to compensate for the time constant at the non-inverting input produced by resistance chain R90–R93 with C34 and stray capacitance to common.

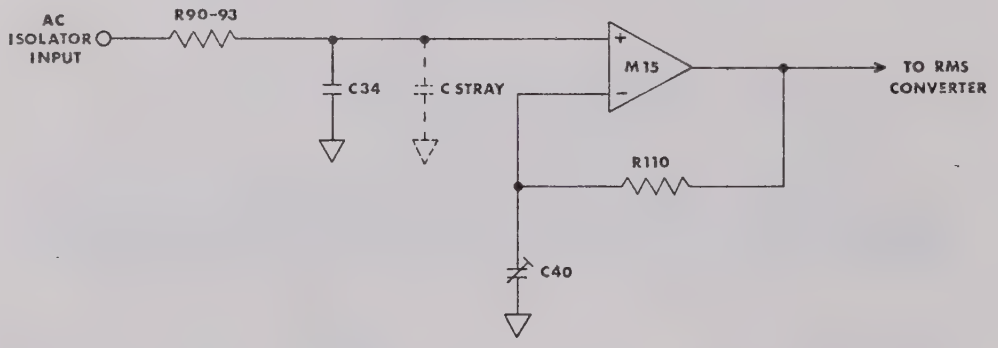


FIG 1.14 PREAMPLIFIER FREQUENCY COMPENSATION

The output of the preamplifier is zeroed by adjustment of F.S.V. resistors R107 and R108.

1.2.3.5 R.M.S. Converter

The RMS Converter takes the scaled ac signal from the preamplifier and converts it to an equivalent DC signal suitable for Analogue-to-Digital conversion. The conversion technique is electronic true RMS sensing as shown in the simplified block diagram Fig. 1.15.

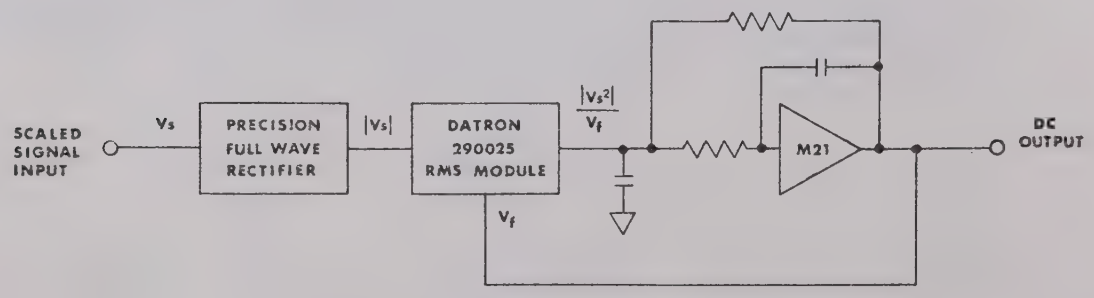


FIG 1.15 TRUE RMS CONVERTER

Mathematically, the description is as follows:–

$$\text{Output voltage, Vo} = \frac{\overline{|Vs|^2}}{Vf}$$

where bar notation indicates averaged.

Vs is the rectified form of the input signal Vs.

Since the loop is closed.

$$Vo = Vf$$

therefore $Vo^2 = \overline{Vs^2}$ $\quad (Vs^2 = |Vs|^2)$

so $Vo = \sqrt{\overline{Vs^2}}$

Thus Vo is the true RMS value of Vs.

For a dc coupled signal the RMS value is:

$$Vo = \sqrt{\overline{Vdc^2 + Vac^2}}$$

M18 and M19 form the full-wave rectifier which is of the summing type, that is M18 is a precision half-wave rectifier inverter the output of which is summed with the non-inverted signal, with a weighting of 2:1, at the input of M19. This forces a full-wave rectified current to flow in RMS module M20. Although the simplified block diagram of Fig. 1.15 implies that the RMS module operates with voltages it in fact operates on currents both in and out. Trim resistor R126 balances the rectifier such that a dc input or any other non-symmetrical waveform provides the same output whether inverted or not.

The output current from the RMS module passes into a 2 pole active filter-buffer M21 and is converted to a proportional voltage. In practice this is attenuated 5:1 by the ratio of R154 and R156 to obtain a nominal 1 volt full range output. M22 is a voltage to current converter which provides a feedback current to the RMS module which is proportional to the output voltage. R119, R131, R147 and R150 are zero adjustments for M18, M19, M21 and M22 respectively. R157 is an overall gain adjustment and R138 is a high crest factor gain adjustment.

1.2.4 Resistance Converter

1.2.4.1 General

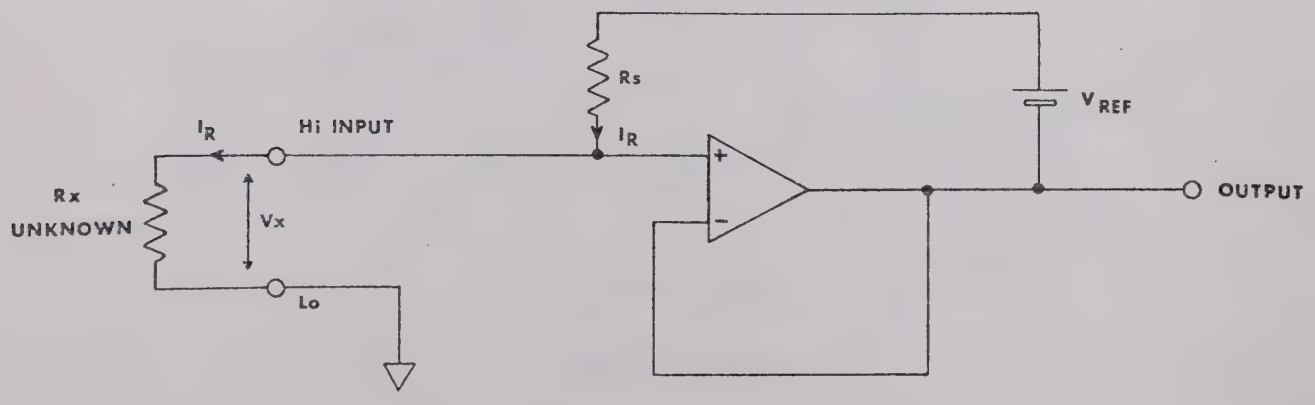


FIG 1.16 SIMPLIFIED OHMS SCHEMATIC

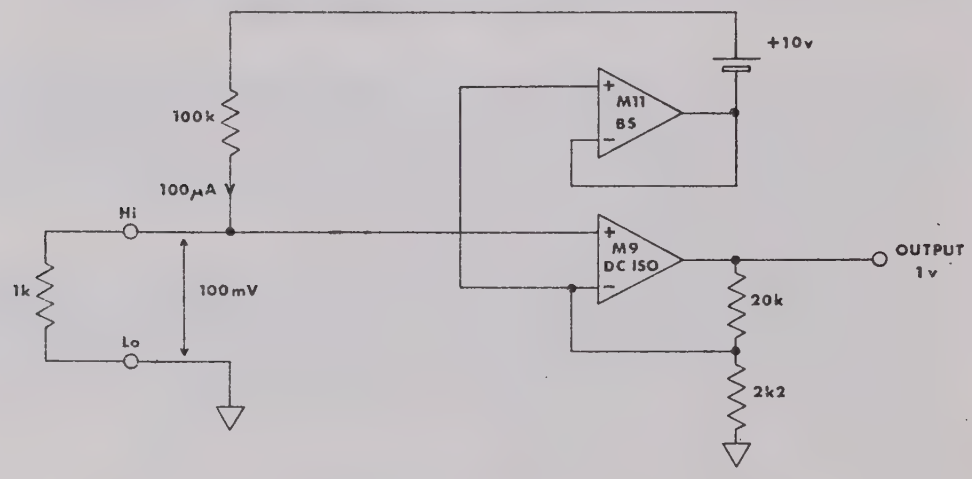
The unknown resistor, Rx, is connected to the input of a unity gain buffer. On the output of the buffer is a floating voltage reference, Vref, which is applied to the precision resistor, Rs. Since the voltage across Rs remains constant a constant current, Ir, flows through Rs. If the buffer has an infinite input resistance, all current flows out of the Hi input terminal of the instrument, through the unknown resistance, Rx and back via the Lo input terminal to common. Hence a voltage, Vx, is developed across the input terminals which is proportional to Rx.

In practice Rs is a trimmed section of the attenuator network (A.N.1), the unity gain buffer is the Bootstrap amplifier, M11, and the voltage reference is the positive bootstrapped supply (see section 1.2.2.4).

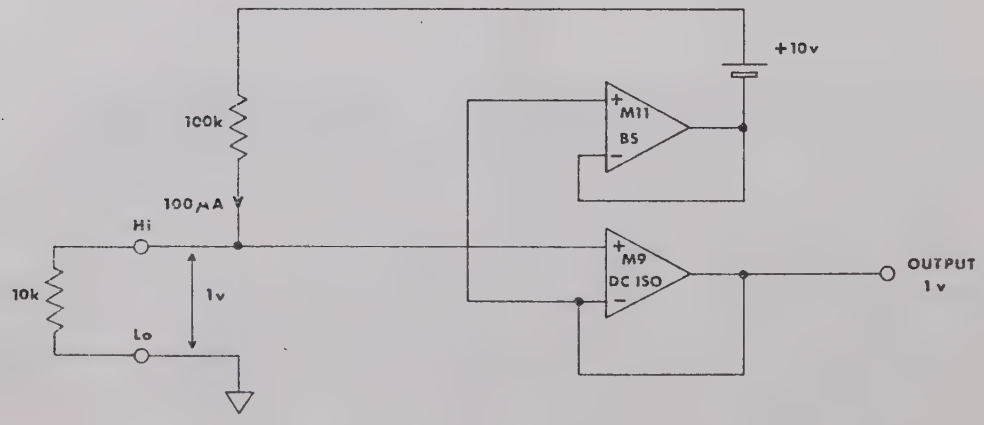
The various currents produced are:–

Range / Function	Current Through Unknown	Voltage Across Unknown (Full range)	DC Isolator Gain
1kΩ	100 μA	100 mV	x10
10kΩ	100 μA	1V	x 1
100kΩ	10 μA	1V	x 1
1000kΩ	1 μA	1V	x 1
10MΩ	100 ηA	1V	x 1

These are generated by the circuits shown in Fig. 1.17.

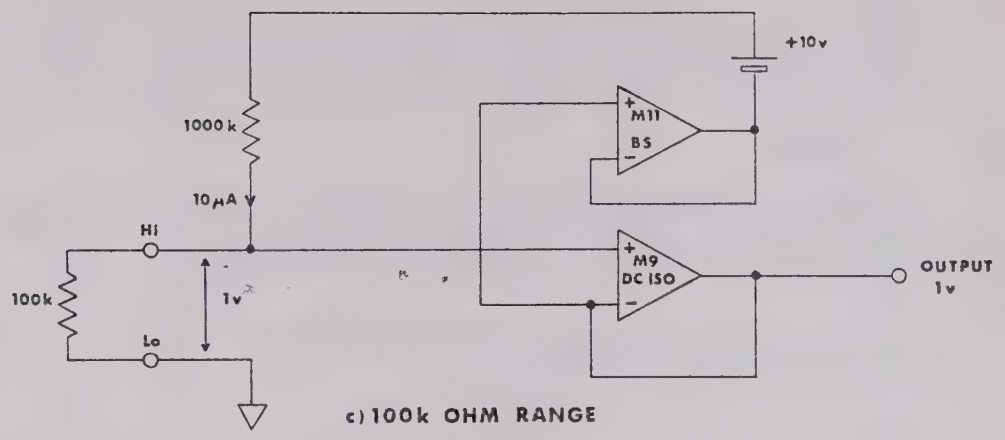


a) 1k OHM RANGE

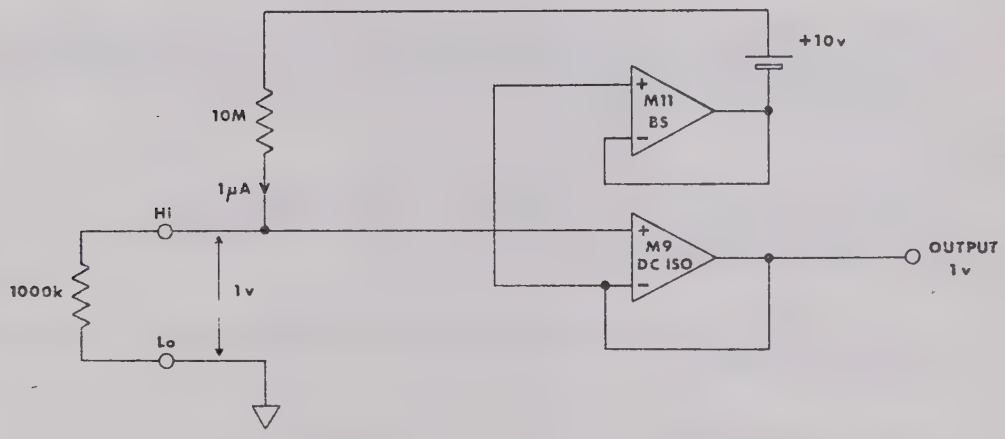


b) 10k OHM RANGE

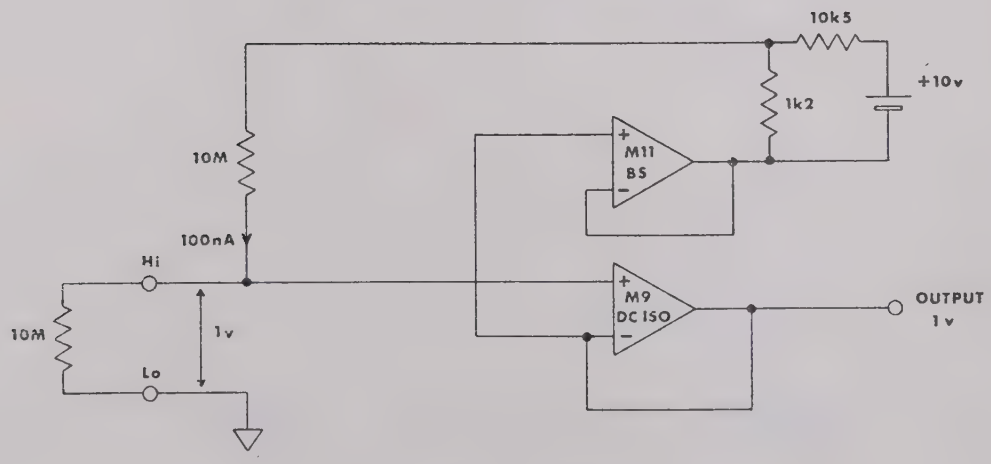
FIG 1.17 SEPARATE OHMS RANGE SWITCHING



c) 100k OHM RANGE



d) 1000k OHM RANGE



e) 10M OHM RANGE

FIG 1.17 SEPARATE OHMS RANGE SWITCHING

NOTE that both 1kΩ and 10kΩ ranges use the same reference current, so the gain of the DC isolator is x10 in the 1kΩ range. The voltage reference is set as the calibration for the 10kΩ range. Hence each other range is calibrated by adjusting the source resistor, Rs, to be in the correct ratio to the 100kΩ source resistor, used for the 10kΩ range. In the 10MΩ function the reference voltage is attenuated by 10 to obtain the 100nA current reference.

Keeping the source resistor, Rs to a minimum value of 100kΩ permits application of 250V r.m.s. to the input terminals in all ohms ranges. Following gross overloads several minutes should be allowed for the attenuator network to cool down before continuing with measurements.

A zero offset control, R45 enables internal lead resistance to be compensated. This injects an offset at the DC isolator in the 1kΩ and 10kΩ ranges.

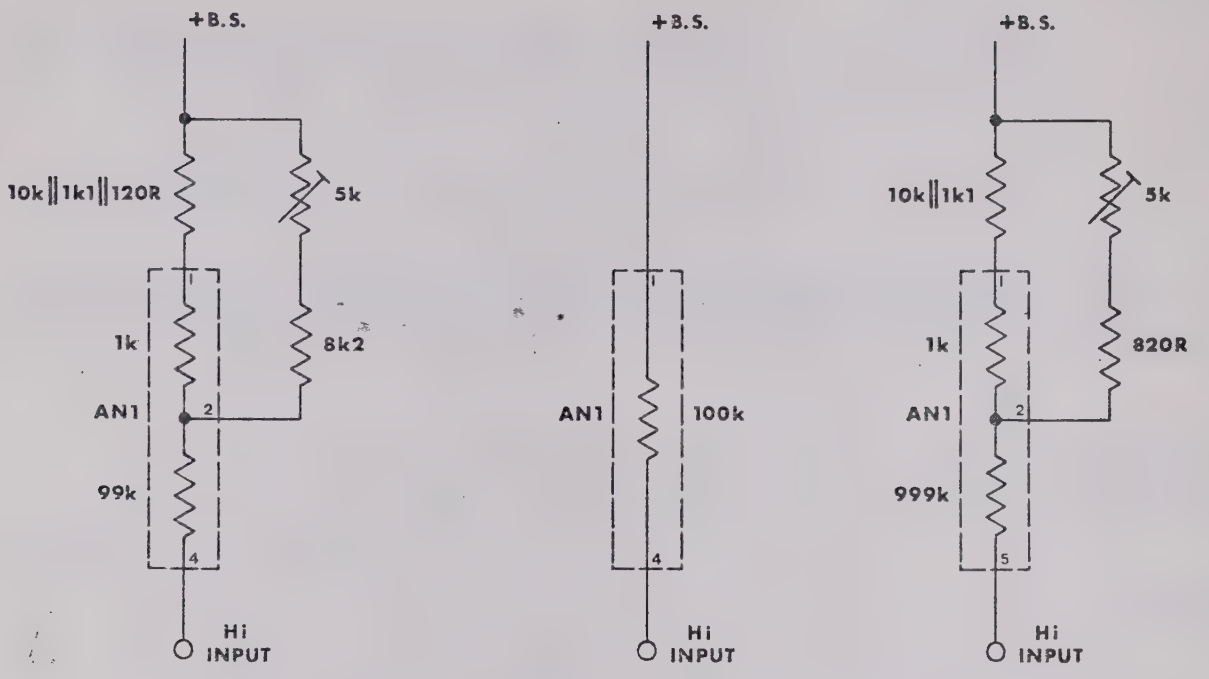
1.2.4.2 **Source Resistance Calibration**

As stated in Section 1.2.2.2 only the ratios of the resistors used in the current source are important. The absolute value of resistance for each range is not critical once the reference voltage has been adjusted to calibrate the 10kΩ range. Therefore each resistor can be calibrated by the same method adopted in the DC voltage calibration (See Section 1.2.2.2).

In each case only the lower part of the attenuator network is used, except for the 1000kΩ and 10MΩ ranges where all the network is required. Therefore, to trim in the 10MΩ current source resistance for the 1000kΩ range a higher tapping on the network is used.

Note that the 'low' end of the attenuator (in volts) is switched to the positive bootstrapped supply for resistance measurements.

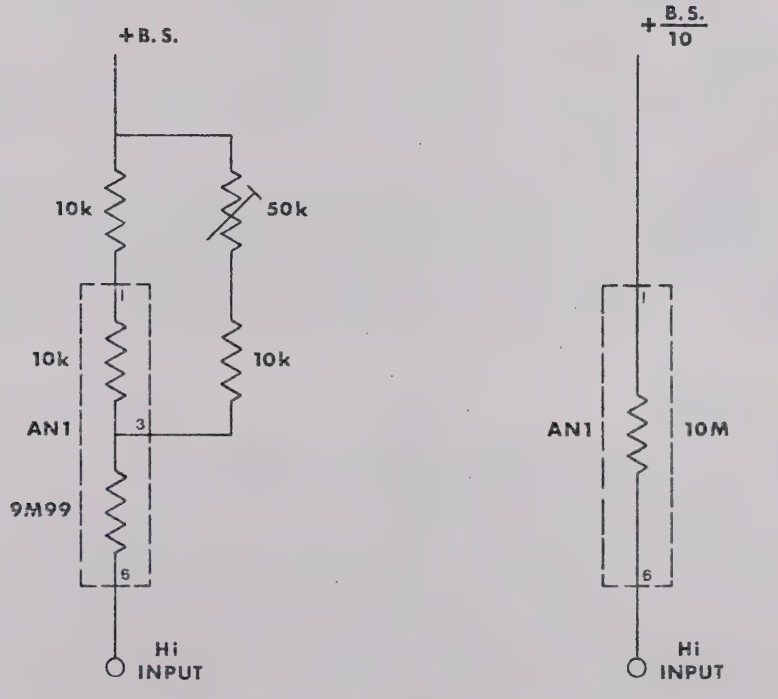
The current source resistor for each resistance range and function is shown in Fig. 1.18.



a) 1 kΩ RANGE

b) 10 kΩ RANGE

c) 100 kΩ RANGE



d) 1000 kΩ RANGE

e) 10 MΩ RANGE

FIG 1.18 CURRENT SOURCE RESISTANCE

1.2.5 **Range Coding Logic**

The Range Coding logic is used to command appropriate control voltages of the Quad Bilateral Switches and discrete signal switching in the analogue section when a particular Function and Range is selected. Fig. 1.19 gives the truth table of all logical outputs for a given Function and Range.

The power supplies to the logic are derived from the dc bootstrapped supplies (see section 1.2.2.4), i.e. +B.S. and –B.S./2, derived from –B.S. by attenuator R26, R27 and emitter follower, Q5. The logic power supplies are therefore +10V and –5V with respect to the bootstrapped dc input signal.

As the same supplies are used for the Quad Bilateral Switches M1, M2 and M10 the control voltages may be driven directly from the coding logic, M17 is powered from ± 7.5V and so is interfaced to the coding logic by resistors R89, R159, R176 and R177 to limit the current into the input protection diodes.

Range/Function information to the inputs of the logic is derived from the analogue switch banks, S.B.2 and S.B.4.

	IC		M1				M2				M10				M17			
	PIN No.		5	6	12	13	5	6	12	13	5	6	12	13	5(R89)	6(R177)	12(R176)	13(R159)
Function	100mv DC.		0	0	*	*	*	1	0	0	1	0	0	0	1	0	*	0
	DC V	1V	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	1
		10V	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	1
		100V	0	0	0	1	0	1	0	0	0	0	0	1	1	0	1	1
		1000V	0	0	1	0	0	1	0	0	0	0	0	1	1	0	1	1
	AC V	1V	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1	1
		10V	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	1
		100V	0	0	0	1	0	0	1	0	0	0	0	1	1	0	1	1
		1000V	0	0	1	0	0	0	1	0	0	0	0	1	1	0	1	1
	DC V + AC V	1V	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	1
		10V	0	0	0	0	1	0	1	0	0	0	0	1	0	0	1	1
		100V	0	0	0	1	0	0	1	0	0	0	0	1	0	0	1	1
		1000V	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1	1
	KΩ	1kΩ	0	0	0	0	0	1	0	0	1	0	1	0	1	0	1	0
		10kΩ	0	0	0	0	0	1	0	1	0	0	1	1	1	0	0	1
		100kΩ	1	0	0	0	0	1	0	0	0	0	0	1	1	0	1	1
		1000kΩ	0	1	0	0	0	1	0	0	0	0	0	1	1	0	1	1
	10MΩ		0	0	*	*	*	1	0	0	0	0	0	1	1	0	*	1

NOTES: 1) LOGIC 1 = +BS V
LOGIC 0 = $-BS/_2$ V

2) * INDICATES STATE DEPENDENT ON RANGE

3) LOGIC INPUTS TO M17 CLAMPED TO <+7.5 V, >–7.5 V.

Fig. 1.19. RANGE CODING TRUTH TABLE.

1.2.6 **A–D Command and Function Indication Circuit**

The A–D Command and Function Indication Circuit provides the A–D board with the Range/Function information necessary to drive the correct decimal point on the display, when to indicate the polarity of the incoming signal and to illuminate the appropriate symbol on the display to describe the selected function.

Power is taken from the A–D board, +5V supply and switching is provided by switch banks S.B.1 and S.B.3. Consequently the circuit is electrically isolated from all analogue circuitry.

All information and the power supply is transmitted through the 'ribbon' cable connector, J3.

1.3 ANALOGUE TO DIGITAL CONVERTER

1.3.1 Analogue Section

1.3.1.1 General Principles

Section 2.2.5 and Fig. 2.2 in the Operating Manual gives a very basic description of the principles of integration involved. This paragraph covers in more detail those general principles. Fig. 1.20 is a block diagram showing the essentials of the analogue section of the Analogue to Digital Converter. Fig. 1.21 is a timing diagram which should be referred to in conjunction with Fig. 1.20 for a full appreciation of the circuit operation.

The analogue section is controlled by timing pulses generated in the digital section and transferred via pulse transformers T2 and T3 to the analogue side. These timing pulses control the sequence from RESET to SIG to REF and back to RESET. The sequence is effected by using the timing pulses to set and then clock a 2 bit binary counter M44. The 2 bit output $\overline{AB}$ and its complement, AB drive logic gates which in turn operate F.E.T. switches Q1 – Q4, Q6 – Q9.

1.3.1.2 RESET Period and Auto Zero

During this period any residual charge from the previous reading cycle is removed from the integrator capacitor C30, and the AUTO ZERO circuitry stores the cumulative zero errors of M35, M36 and M37.

The RESET state is dictated by LOW (–15V) states at both A and B from M44, when this occurs a HIGH (–10V) state appears at the input pins 5 and 6 of the M46 NAND gate producing a LOW (–15V) at pin 4. This turns off Q18, which switches Q4 (FAST RESET) ON momentarily (approx 1mS) via C17 and R26, and after a short delay (approx 1 mS) set by C38 and R22 allows Q3 (RESET and Auto Zero) to switch ON. When B went to a logic '1' at the end of the previous SIG period, it reset M45 F/F to give a LOW state at the Q output (pin 13) which turned OFF Q14 allowing Q2 to turn ON and turning OFF Q1. These states of Q1 and Q2 are maintained from the end of SIG through to REF and RESET.

Also at the commencement of RESET $\overline{B}$ changes to a HIGH (–10V) state. This appears at pin 13 and 12 of M46 NAND gate causing the output pin 11 to go LOW and turns OFF Q23 allowing F.E.T. switch Q8 to turn ON.

Now, during RESET the F.E.T. switches are in the states shown in Fig. 1.21. Q8 connects the output of M35 to the input of the integrator. Q3 and Q4 close the feedback loop and C30 assumed a charge such that when C32 samples the cumulative errors of M35, M36 and M37, the stored error is transferred via M49 to the non-inverting input of M38 to produce zero volts at TP9. This auto zero output from M49 is maintained during the following SIG and REF periods until being adjusted again, if necessary, during the next RESET period.

1.3.1.3 SIGNAL Integrate Period

Following the RESET period, a timing pulse arrives at T3 the SIG pulse transformer. This sets the binary counter, forcing A to a HIGH state (–10V) and ensuring that B is a Low state (–15V). The SIG pulse also appears at the clock input pin (11) of 'D' type flip-flop M45, the Q output (pin 13) thus adopts the signal at the D input (pin 9), –10V, and therefore goes to a HIGH state. This switches ON Q14 which switches on F.E.T. Q1 and switches OFF F.E.T. Q2. Q1 connects the unknown signal to the X5 amplifier input. Q8 is already ON following the RESET period and X5 the input signal appears at TP5 and is fed to the integrator. If the signal at TP5 is positive then the output of the integrator at TP7 will move off negatively as shown in Fig. 1.21. Meanwhile, the voltage at TP7 is much amplified by the first stage of the null detector M37. This stage incorporates clamping diodes D18 and D19 so that although a large output swing occurs when the voltage at TP7 departs from zero by only a small amount, the voltage at TP8 is clamped, again as shown in Fig. 1.21. Further null detector gain is introduced by M38 and through level shifting zener diode D23 to M42. At TP10, the null detector gain is such that the output is a logic level of either 0V for a negative signal or +15V for a positive signal as shown in Fig. 1.21. The logic voltage at TP10 is level shifted by zener diode D25 to provide either –9V or –15V via R29 at the D input (pin 5) of the 'D' type flip-flop M45. With a positive input signal the voltage at pin 5 is HIGH (–9V).

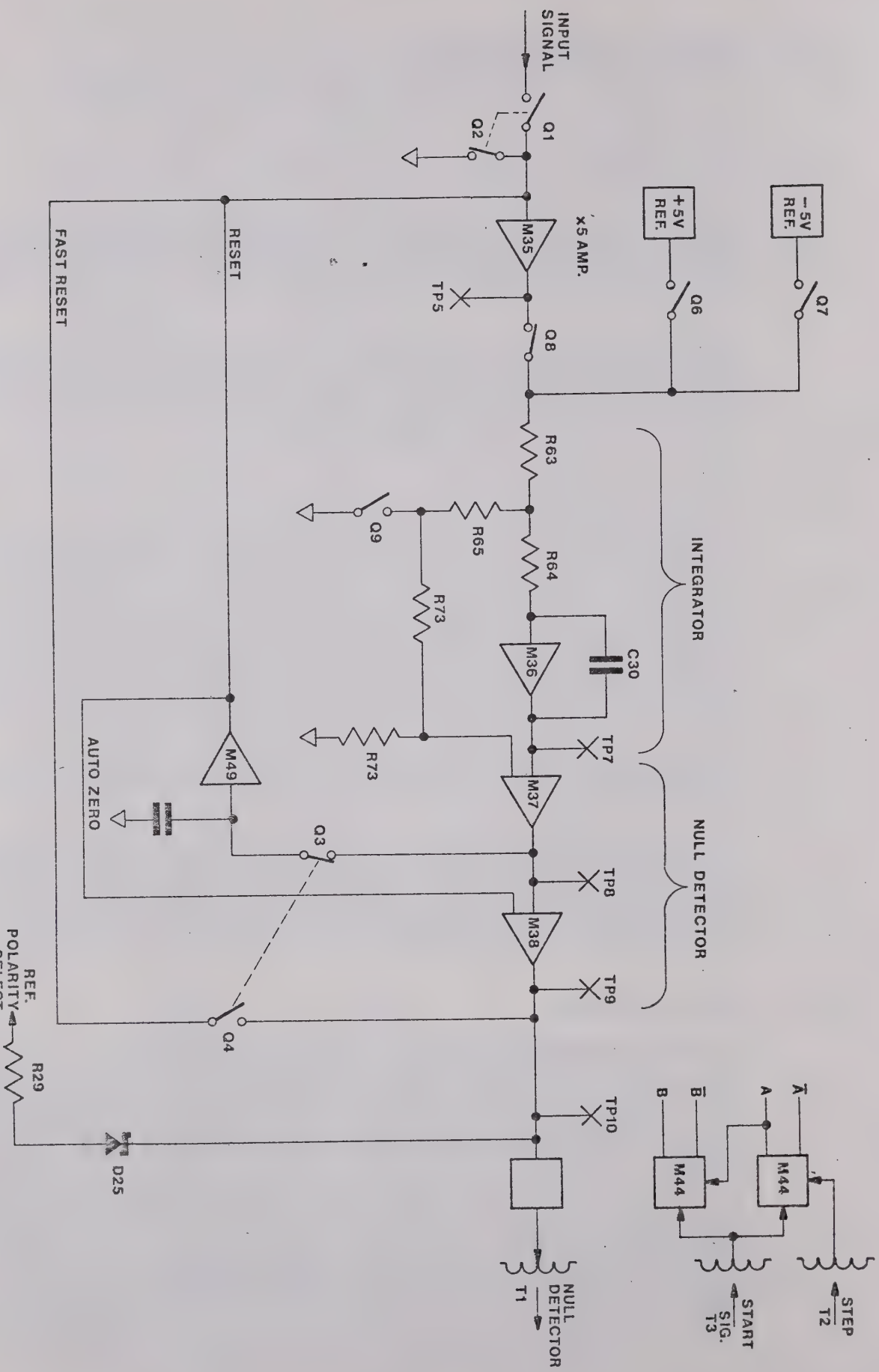


FIG. 1.20

SIMPLIFIED DIAGRAM OF ANALOGUE SECTION

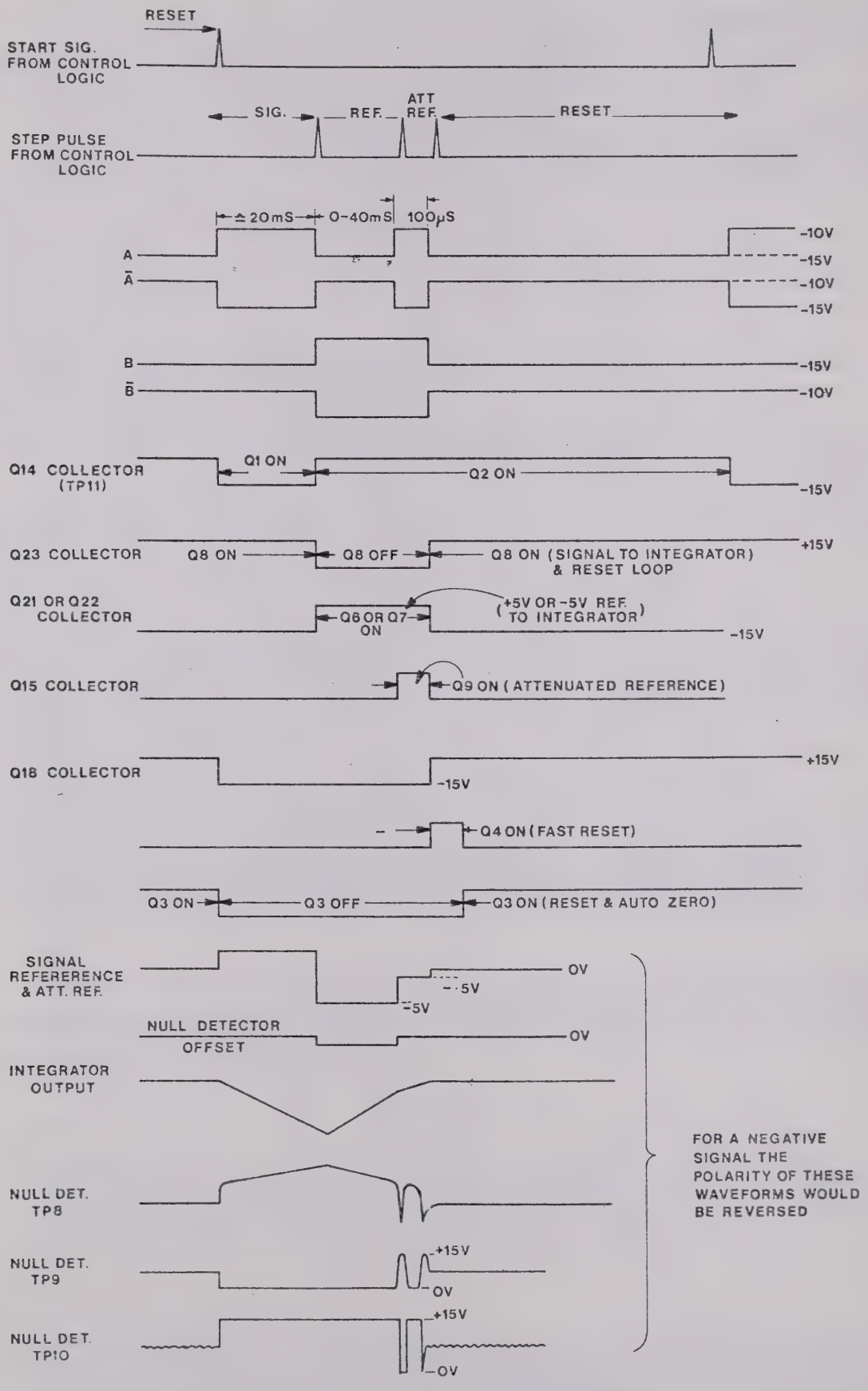


FIG. 1.21

A-D CONVERTER TIMING DIAGRAM

1.3.1.4 **REFERENCE Integrate Period**

After 20 mS of SIG a STEP pulse arrives at pin 3 of M44 to clock M44 and change A to a LOW (–15V) and B to a HIGH (–10V). $\overline{B}$ at NAND gate pin 13 changing to a LOW (–15V) produces a HIGH (–14.3V) at the output pin 11 and turns ON Q23 which switches OFF the signal path through Q8.

As explained in paragraph 1.3.1.3 with a positive input signal a HIGH state (–9V) is present at 'D' input (pin 5) of 'D' type flip-flop M45 at the end of the SIG period.

Therefore, when $\overline{A}$ changes to a HIGH on the clock (pin 3) input of M45 at the end of SIG, the HIGH at the 'D' input (pin 5) is transferred to the Q output (pin 1). At the same time a LOW (–15V) appears at the $\overline{Q}$ output (pin 2), which turns OFF Q22 allowing F.E.T. Q7 to switch ON, thus connecting the –5V reference to the input of the integrator. Consequently, a reference signal of opposite polarity to the measured signal is applied to the integrator to discharge the capacitor. The reference integrator period required for discharging the capacitor C30 to zero volts will always be less than 40 mS (except with an overload signal). To overcome the problem of uncertainty near zero a small proportion of the reference voltage is fed forward to bias the null detector. This means that even with zero input signal there is a small reference ramp lasting for a period of time determined by the amount of feed forward (set by R80 for positive signals and R81 for negative signals). This ensures that a false null detector pulse is not produced as a result of spurious noise generated at the end of the SIG period. For a zero input the display would read several digits, and this is compensated for in the main digital counter by ignoring the first few clock counts.

During the first part of the reference period, F.E.T. switch Q9 is turned OFF. This allows the reference voltage, attenuated by R73 and R72 to feed a small offset into the null detector. The polarity of the offset is such that the reference ramp from the integrator (TP7) reaches null detector threshold before the integrator voltage has reached 0V. When this threshold is crossed, the logic level at the null detector output changes state, in this case from HIGH, (+15V) to LOW (0V), which transfers a first null detector pulse via T1 to the control logic. Following an appropriate synchronization delay in the control logic another STEP pulse arrives at T2 to clock M44, this changes A to a HIGH state (–10V). This means that both inputs (pins 1 and 2) of NAND gate M46 are HIGH, producing a LOW state (–15V) at pin 3, turning Q15 OFF which allows Q9 to turn ON. When Q9 switches ON, the reference voltage is attenuated by R63 and R65 and is effectively –0.5V, also the small offset fed to the null detector via R73 and R72 is removed. The removal of this offset immediately resets the null detector to its previous state with a HIGH (+15V) at TP10. The reference to the integrator having been attenuated to 1/10 of its previous value, means that the integrator capacitor C30 now discharges at 1/10 of the previous rate and continues until zero charge is reached. At this point the threshold of the null detector, now 0V, is again crossed and the logic level at the null detector output again changes to LOW (0V) transferring a second null detector pulse via T1 to the control logic. The attenuated reference period lasts for approx 100 S, whereas the full reference period varies from almost zero to 40 mS for a zero to full scale input signal respectively. Following the second null detector pulse another STEP pulse arrives at T2 which clocks M44, changing both A and B to a LOW (–15V) and thus switching the analogue circuitry back into the RESET mode as described in paragraph 1.3.1.2.

1.3.1.5 References

Fig. 1.22 shows the essentials of the circuitry for producing the stable +5V and –5V reference voltages.

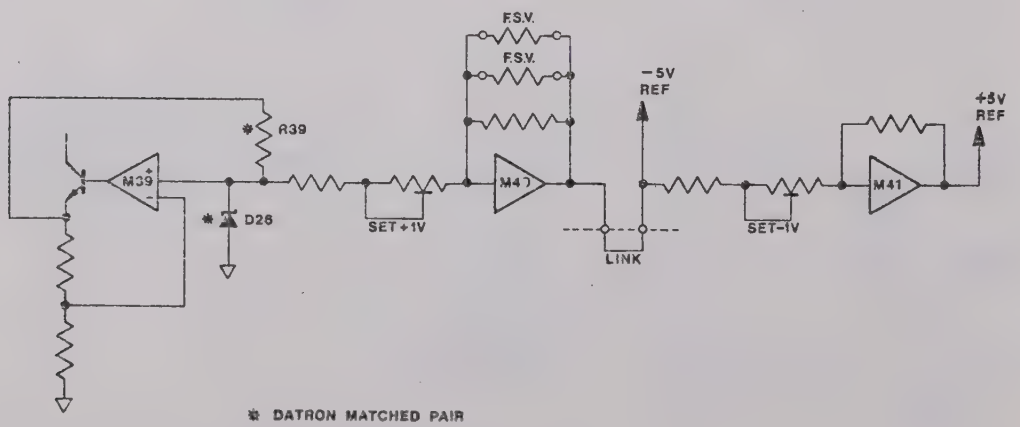


FIG. 1.22
REFERENCES

The stability of the reference is dependent upon the inherent stability of the reference zener, D26. This zener is selected by Datron for maximum long term stability and minimum temperature coefficient. The series resistor R39 is selected for use with each individual zener and both are included as a matched pair.

For optimum stability R39 and D26 are used in conjunction with amplifier M39 to produce a voltage of approx 11 volts to supply the current for the zener itself. By this means an extremely stable voltage of approximately +6.3 volts is produced at the cathode of D26. To obtain the 5V ref required, inverting amplifier M40 is used, the feedback resistance R67 being trimmed by R70 and R71 and using R76 as a fine adjustment to calibrate the output of M40 to precisely –5V. Similarly, to produce the +5V reference, another inverting amplifier M41 is used, having unity gain and being finely trimmed by R28.

1.3.2 Digital Section

1.3.2.1 General Principles

Block diagram Fig. 1.23 outlines the essentials of the digital section and should be used with diagram 1.24 in order to follow the operation of this section.

The function of this section of the circuitry is to generate the timing pulses that when transferred to the analogue section, control the sequence from RESET to SIG to REF and back to RESET. Concurrent with this sequence, clock pulses are accumulated in a digital counter such that when the sequence is in the REF period, the number of clock pulses entering the counter is proportional to the length of that REF period, which is in turn proportional to the measured input signal. At the end of each reading cycle the count is stored and fed to the displays.

1.3.2.2 Command

To instruct the control logic to take a reading a COMMAND pulse is necessary at the Command enable flip-flop M21. COMMAND is generated internally by the read rate astable M27 providing for 3 readings / sec. When a COMMAND is received the Command enable flip-flop changes state which inhibits further Commands and admits 500 kHz clock pulses from the clock to the least significant digit decade counter M9 and the cascaded decade counters M4.

1.3.2.3 Counter, Latches and Multiplexing

M4 is a large scale integrated circuit which contains the main counter and store (four full decades, one overrange latch and one overload latch) and also provides a multiplexed BCD output of the count stored in the four decade latches. The fifth decade counter M9 (least significant digit) is stored by M6 and its BCD output is introduced onto the multiplexing lines every fifth step pulse from the multiplex oscillator M19, by the logic 4 pole 2 way changeover switch M3. The multiplexed lines are decoded by M2 to produce data in seven segment format.

Before a COMMAND is received and until a subsequent TRANSFER pulse arrives, the stored count from the previous reading is multiplexed out to the display, the multiplexing frequency being approx 1 kHz. The most significant digit (indicating a count of 100,000 or greater) is not multiplexed but is stored by M13 and fed directly to the most significant digit display.

1.3.2.4 Master Preset

Coincident with the first clock pulse after a COMMAND a MASTER PRESET pulse (approx 2 μs) is generated and is fed to M4. This sets the 4 decade counters to all zero's and the binary overrange and overload latches to 1's (equivalent to a count of 30,000). The least significant decade M9 although receiving clock pulses is not allowed to count but is held preset at a count of 9.

1.3.2.5 Signal Integrate Period

A summary of the states of the counters during one reading cycle is shown in Fig. 1.25. As mentioned, following a MASTER PRESET pulse 1's appear at the overrange and overload latch outputs of M4 and remain in this state until a further 10,000 clock pulses have been counted when the clock resets to 00,000. At 500 KHz, 10,000 clock counts defines a period of 20 mS and this period is used to determine the SIG period. At 30,000 a Start Sig timing pulse is sent to the analogue section via T3 and after another 10,000 clock pulses a step pulse is sent via T2, this terminates the SIG period and starts the REF period.

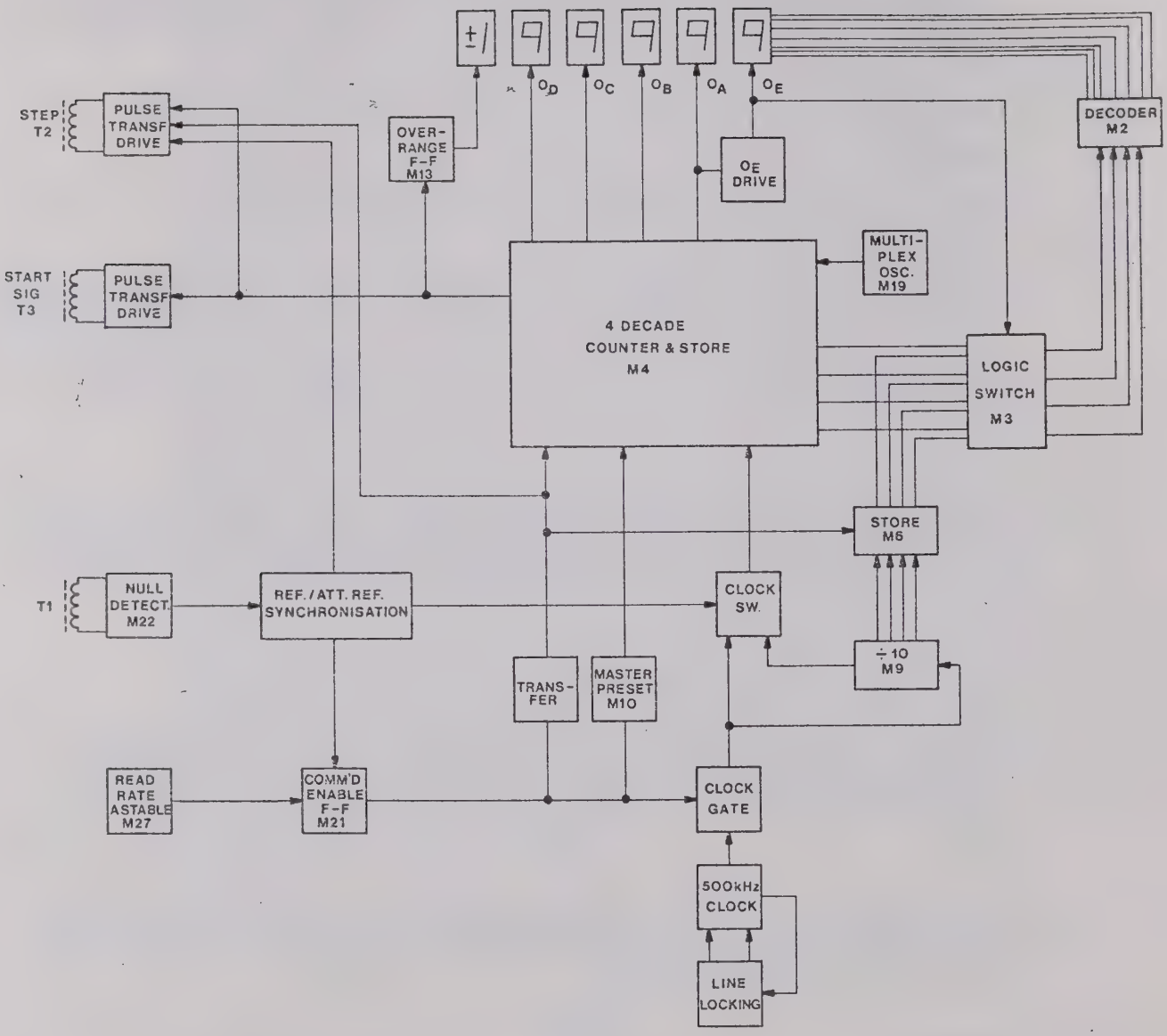


FIG. 1.23

SIMPLIFIED DIAGRAM OF DIGITAL SECTION

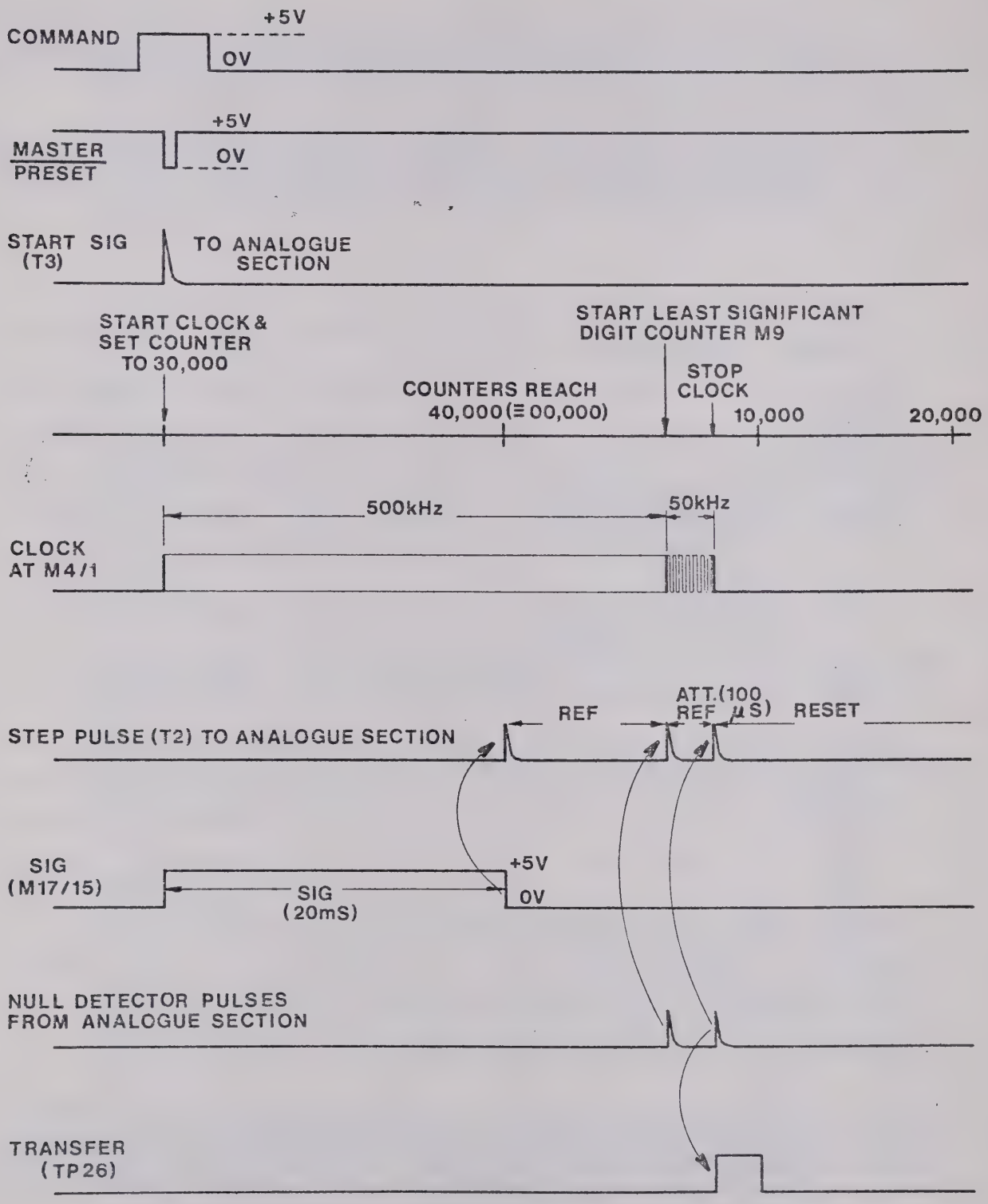


FIG. 1.24

DIGITAL SECTION TIMING DIAGRAM

1.3.2.6 **Reference Integrate Period**

During the REF period the clock pulses continue to accumulate in the M4 counters, M9 still being held at 9, until a null detector pulse is received from the analogue section via T1. This pulse is stored by M16 flip-flop which removes the hold on the least significant digits counter M9. In synchronism with the next clock pulse the clock input to M4 is switched from the 500 kHz clock to the output of M9 (50 KHz) and a step pulse is sent via T2 to the analogue section to start the attenuated REF period.

Clock pulses now feed the five cascaded decade counters M9 and M4 until the second null detector pulse appears at T1. This pulse is used to reset the state of the Command flip-flop M21 enabling further commands to be accepted, and the 500 kHz clock to the counters is gated out preventing further accumulation of clock pulses.

FIG 1.25	SUMMARY OF COUNTER SEQUENCE	MOST SIGNIF. DIGIT (BINARY)	DECADES	CLOCK TO M4	LEAST SIGNIF. DIGIT	CLOCK
READING FROM PREVIOUS CYCLE		01	4573		6	CLOCK STOPPED
START SIG.	COMMAND PRODUCES MASTER PRESET WHICH SETS 30,000 AND HOLDS LEAST SIGNIFICANT DIGIT AT 9	11	00000 ←	500kHz	9 ←	START CLOCK 500 kHz
END SIG.	AFTER 10,000 CLOCK PULSES (≙20mS) COUNTER AT 00,000 (≙40,000) LEAST SIGNIF. DIGIT STILL HELD AT 9	00	00000 ←	500kHz	9 ←	500kHz
START REF.	1 CLOCK PULSE LATER	00	00001 ←	500kHz	9 ←	500kHz
FIRST NULL DETECTOR PULSE	COUNTER HAS REACHED, FOR EXAMPLE:	01	4562 ←	500kHz	9 ←	500kHz
START ATT. REF.	1 CLOCK PULSE LATER	01	4563 ←	50 kHz	0 ←	500kHz
FINAL READING	SECOND NULL DETECTOR PULSE STOPS CLOCK & PRODUCES TRANSFER	01	4568		2	STOP CLOCK

1.3.2.7 **Transfer**

When the COMMAND enable flip-flop is reset by the second null detector pulse, a TRANSFER pulse is generated by M21 to instruct the counter latches M4 and M6 to store the new count, which is then multiplexed out to the displays. Coincident with the TRANSFER pulse a third step pulse is passed via T2 to the analogue sector to start the RESET period. Both the analogue and digital sections remain in this state until the next COMMAND pulse arrives.

1.4 DISPLAY

The Display comprises seven segment cold cathode (Beckman – Sperry) enunciators operating from a 180V DC supply line. The complete assembly is mounted on the front of the A – D assembly and at right angles to it. The segment drive lines from the decoder driver on the A – D pass via the soldered right angle connector directly to the pins on the displays. The five decade displays are multiplexed by the anode switches Q1 to Q5, the seven segments of each decade being connected in parallel and taken to the decoder driver M2 on the A – D assembly. The decimal points DP2 to DP4 are driven by Q10 and multiplexed by Q1 to Q3 with the decade displays. The decimal point DP1, the overrange digit and the + and – indicators are multiplexed in parallel with the two least significant decades by Q4 and Q5. The inputs to the anode switches Q1 – Q5 are AC coupled from M1 buffer which is fed from M4 on the A – D assembly.

1.5 POWER SUPPLIES

1.5.1 General

The mains transformer and power supply components are situated along the right hand side of the Analogue – Digital board when viewed from the front. Transformer T4 is of toroidal construction with a split primary comprising two 115V windings. These are intended for either series or parallel connection, depending on the line voltage. An earth screen is interposed between primary and secondary windings to minimise electrostatic coupling, this is grounded to line earth. Entirely isolated from the earth screen and all windings is a further electrostatic screen fitted to act as a Guard Screen.

1.5.2 +15V, –15V and +5V Supplies

Mains Transformer T4 has three secondary windings each with its separate bridge rectifier and solid-state regulator. Outputs from M47 and M48 are connected in series to provide DC supplies required for the entire analogue circuitry throughout the instrument. These regulators are capable of 500 mA output.

The third regulator M50 produces the +5V DC supply, which is used to power all the logic circuitry in the instrument and the DC inverter for the +180V Sperry supply. This regulator is capable of 1 ampere output and all regulators include foldback current limiting and thermal shut-down, to provide short circuit protection.

1.5.3 +180V and –8V Supplies

The +180V supply is required for the seven segment cold cathode (Beckman – Sperry) displays, and the –8V for the VGG supply to PMOS integrated circuit M4.

The +180V is produced by a DC to DC converter stepping up from the +5V supply. Transistors Q40, Q41, form an astable multivibrator driving Q42 which switches the centre tap of the primary of the step-up transformer T5 to 0V at approximately 12 KHz. One side of the primary is connected via L1 to +5V and the other half of the primary acts as an auto-transformer to produce a voltage switching from +5V to –5V.

When this voltage is +5V capacitor C106 charges through R107 and D32, when the transformer voltage switches to –5V, C106 being already charged to 5V produces –10V as its negative terminal. Capacitor C107 then charges through D31 from C106. After several switching cycles the negative voltage at C107 builds up and is limited to –8.2V by Zener Diodes D33. The secondary produces a high voltage square wave which is rectified and smoothed by W4 and C108.

SECTION 2

MAINTENANCE

2.1 INTRODUCTION

2.1.1 General

Regular maintenance of the instrument will enable the user to have confidence in measurements made as well as ensuring the highest accuracy possible.

Normally this will consist of checking the calibration at, or before, the end of the guaranteed specification validity period and adjusting where necessary.

Section 5 of the Operating Manual gives a routine for checking the instrument is working within its specified accuracy and may be used as the first stage of an instrument check.

Any readings found to be grossly out of specification should be treated with suspicion as they may indicate a fault.

A routine calibration procedure is given in Section 2.2 of this manual.

Following repair or component replacement, the procedures in Section 2.3.2 of this manual relevant to the repaired part should be carried out prior to performing a full routine calibration.

Before attempting any calibration it must be ensured that the test equipment is of sufficiently high accuracy. The test equipment required is specified in Section 2.2.2. It is also recommended that Section 1, Technical Description, be read before commencing, in order that some idea may be gained of the purpose and possible interaction of the various adjustments.

The circuit diagrams and printed circuit board layouts are contained in Section 4 of this manual.

In case of difficulties or for general advice in servicing your instrument, do not hesitate to contact our Customer Service Department. (For the address and telephone number see the front of this manual).

2.1.2 Removal of Covers – Access for Calibration or Repair

Access to the interior of the instrument for routine calibration, or repair, is achieved by removing the four screws securing the top cover, two screws at each side, and lifting the cover clear of the instrument. Removal of the bottom cover is achieved in an identical manner. The top cover provides access to the Analogue to Digital Converter. The bottom cover provides access to the Analogue Board. With both covers removed the instrument is still operational. It may be inverted without component damage and full mechanical rigidity is maintained during servicing operations.

NOTE: The front panel terminals are insulated from the instrument case, enabling the internal circuitry to float at potentials greater than earth, so the potential of the internal Guard Shields can also reach dangerous levels. In addition, mains supplies appear on exposed conductors in the instrument. Therefore great care should be taken when handling an instrument with covers removed if the input terminals are connected to an external source or the mains supply is connected.

Access to the Display Board is achieved by removing the front panel. Disconnect the mains supply to the instrument and any connections to the input terminals. Remove the top and bottom covers as described in previous paragraph. Disconnect all internal leads from the input terminals. Remove the four screws fastening the front panel to the side panels, two screws each side. Draw the front panel forward until it clears the switches and remove the front panel to gain access to the Display Board (it should not be necessary to disconnect the 'power' switch).

2.2 ROUTINE CALIBRATION

2.2.1 General

The following section contains a calibration procedure which should be carried out at the end of the Specification Validity period, stated in Section 2.3.1 of the Operating Manual, or when the instrument is found to be out of specification.

Following repair or replacement of components, complete calibration of the instrument should be carried out consisting of the part of Section 2.3.2 of this manual applicable to the repaired board, followed by the routine calibration.

During routine calibration full range adjustments are, in general, all that is required to bring the calibration of the instrument well inside its specified accuracy. Linearity and zeros need only be checked to verify the performance, thus saving considerable time. This applies to all functions except d.c. voltage where resetting of linearity is advisable. Steps which are normally not necessary for a routine calibration are marked *.

In the case where a particular function is not required, or the appropriate calibrator is not available, the function need not be calibrated except for 1 volt d.c. range (1, DCV) where resistance is required. Similarly, the higher voltage ranges need not necessarily be calibrated.

Calibration of functions required should always be in the sequence given.

Routine calibration should be completed at an ambient temperature of $23^{\circ}C \pm 1^{\circ}C$ if the instrument is to meet its specification over the given operating range. Before commencing calibration allow 2 hours 'warm up' at this temperature with the upper and lower covers fitted in position but not fastened in place.

For the greatest accuracy and for minimum time spent calibrating, it is necessary for the boards to remain at their normal working temperature throughout calibration. Each trim adjustment is to be made as quickly as possible and in the order described. Operate the instrument in its normal operating position as much as possible (i.e. tilt the instrument in preference to turning it over when calibrating the Analogue Board). Remove the covers for as short a time as possible, replace loosely after each adjustment in order to minimize thermal gradients and loss of heat in the instrument (particularly when calibrating d.c.). Check the reading has stabilized before moving to the next step in the calibration procedure.

After calibration procedure has been completed the instrument should be left in its normal operating position for at least one hour to ensure the internal temperature has fully stabilized. If the calibration procedure is now repeated it will be possible, with relatively few adjustments, to bring the instrument to optimum calibration. Steps marked * need not be completed at this final stage of calibration.

Extreme care should be exercised when handling high voltages, particularly in excess of 100V.

Refer to the Operating Manual, Section 4.5, if in doubt as to the correct use of 'Guard' during the calibration procedure.

2.2.2 Test Equipment Required

Test equipment specifications for calibration and performance verification are given below. Generally, calibration sources should only be used where the accuracy specification exceeds that of the instrument by a factor of at least 4.

2.2.2.1 DC Calibrator

Output voltage ranges:	100mV*	
	1V	in 10 μV increments with 100% overrange i.e. 1.99999 count.
	10V)	
	100V)	Source resistance $<1\Omega$
	1000V)	
Accuracy:	0.0037% reading $\pm$ 0.0005% range $\pm$ 1 μV.	

* Note:– In order to overcome thermal e.m.f.'s generated in the calibrator or leads it is recommended that a precision 100:1 attenuator ($<100k\Omega$ source), connected directly to input terminals of instrument, is used to obtain the 100mV voltage source.

2.2.2.2 **AC Calibrator**

Output voltage ranges: 10mV, 100mV, 1V (with 100% overrange), 10V, 100V, 1000V r.m.s.
Accuracy: 0.025% reading ± 0.025% range, 40Hz – 5kHz.
0.05% reading ± 0.05% range, 3kHz – 30kHz.

2.2.2.3 **Precision Resistors**

A set of standard resistors, i.e.:–

1kΩ, 10kΩ, 100kΩ	± 0.0037%
1MΩ	± 0.0075%
10MΩ	± 0.1%

2.2.2.4 **DC Voltmeter**

A fully floating DC Voltmeter with 1 μV resolution.

Accuracy: 0.01% reading ± 0.01% Range.

2.2.2.5 **Oscilloscope**

Oscilloscope with sensitivity of 10mV/division and 5MHz bandwidth. Horizontal and vertical controls calibrated to ± 5%.

2.2.2.6 **Frequency Counter**

A Frequency Counter capable of measuring 500,000 Hz ± 10Hz.

2.2.2.7 **Temperature Controlled Calibration Room**

Final calibration should be completed in a temperature controlled environment of 23°C ± 1°C., i.e. if the instrument is to meet the accuracy specification given in the Operating Manual over the specified temperature range.

2.2.3 **Procedure**

2.2.3.1 **General**

Read Section 2.2.1 before proceeding.

All adjustments are to the Analogue Board (Assembly Drawing No. 400158) except where otherwise stated. Other adjustments are to:–

Analogue to Digital Converter Board
(Assembly Drawing No. 400161).

Abbreviations: T.P. – 'Test point'.
w.r.t. – 'with respect to'.

2.2.3.2 **DC Voltage**

*1) Connect the Frequency Counter(2.2.2.6) toT.P.23 w.r.t. T.P. 39 on the A–D Converter Board. Adjust R112 for an indication of 500,000 Hz ± 100 Hz. Remove the Frequency Counter.

2) Apply a short circuit to the voltage input of the instrument. Select 10, DCV i.e. the 10V d.c. range. Adjust R38 ('pA' offset control on the front panel of the instrument) for 0.0000, bouncing polarity.

3) Select 100mV DC. Adjust R54 (' μV' offset control on the front panel of the instrument for 0.000, bouncing polarity.

4) Select 1, DCV. Adjust R82 (A–D Converter) for .00000, bouncing polarity.

*5) Connect the DC Voltmeter (2.2.2.4) to T.P.2 w.r.t. voltage input 'Lo'. Adjust R68 for an indication of zero $\pm$ 20 μV on the DC Voltmeter.

Remove the DC Voltmeter.

6) Repeat steps 2, 3 and 4 until the instrument reads zero in all ranges without further adjustment.

7) Select 100mV DC. Connect the DC Calibrator (2.2.2.1) to the voltage input of the instrument. Select the 1V range on the calibrator and apply 0.00000V. Adjust the zero control on the calibrator front panel (if available) for an indication of 0.000, bouncing polarity on the instrument.

8) Select 1, DCV. Apply +0.00010V. Adjust R80 (+ F/F on the A–D Converter) for +9 digits, bouncing +10 digits.

9) Apply –0.00010V. Adjust R81 (–F/F on the A–D Converter) for –9 digits, bouncing –10 digits.

10) Apply +0.00100V. Adjust R46 ('100 digits' on the A–D Converter) for +100 digits.

11) Repeat steps 4, 8, 9 and 10 until all readings are correct without further adjustment.

12) Apply +1.00000V. Adjust R76 ('+1V' on the A–D Converter) for +1.00000 $\pm$ 1 digit.

13) Apply –1.00000V. Adjust R78 ('–1V' on the A–D Converter) for –1.00000 $\pm$ 1 digit.

14) Apply +1.90000. Check the reading is +1.90000 $\pm$ 6 digits.

15) Apply – 1.90000. Check the reading is –1.90000 $\pm$ 6 digits.

16) Apply +0.01000V. Check the reading is +.01000 $\pm$ 1 digit.

17) Apply – 0.01000V. Check the reading is –.01000 $\pm$ 1 digit.

18) Apply +0.10000V. Check the reading is +.10000 $\pm$ 1 digit.

19) Apply –0.10000V. Check the reading is –.10000 $\pm$ 1 digit.

20) Select 100mV DC. Connect the DC Calibrator to the input via the 100:1 attenuator (see note in Section 2.2.2.1). Apply zero input. Allow any thermals to stabilize then adjust R54 (' μV' offset control on the front panel of the instrument) for 0.000, bouncing polarity.

21) Apply +100.00mV to the input of the instrument (i.e. +10V selected on the DC Calibrator). Adjust R65 for +100.000 $\pm$ 3 digits.

22) Apply –100.00mV to the input of the instrument. Check the instrument reads –100.000 $\pm$ 6 digits. Remove the DC Calibrator and 100:1 attenuator.

23) Connect the 10MΩ resistor (2.2.2.3) to the voltage input terminals. Check the reading settles to less than 450 digits. Remove the 10MΩ resistor.

24) Select 10, DCV. Connect the DC Calibrator (2.2.2.1) to the voltage input terminals. Apply +10.0000V. Adjust R13 for +10.0000 $\pm$ 1 digit.

25) Apply –10.0000V. Check the reading is –10.0000 $\pm$ 4 digits.

26) Select 100, DCV. Apply +100.000V. Adjust R9 for a reading of +100.000 $\pm$ 1 digit.

27) Apply –100.000V. Check the reading is –100.000 $\pm$ 4 digits.

28) Select 1000, DCV. Apply +500.00V. Adjust R5 for +500.00V $\pm$ 1 digit.

29) Apply +1000.00V. Check the reading is +1000.00 ± 15 digits.

NOTE:– When applying 1000V:–

i) Check the DC Calibrator (2.2.2.1) does not exhibit excessive overshoot (i.e. <10%) when the 1000V range is selected. If in doubt, or if overshoot is excessive, increase output from calibrator gradually in 100V steps. Transients exceeding the maximum working voltage may cause internal damage.

ii) Switch DC Calibrator for zero output before applying the opposite polarity – since a 2000V edge (i.e. from +1000V to –1000V) may damage the instrument.

iii) Take care to ensure that greater than 500V is not applied between input 'Lo' and earth.

30) Apply –1000.00V. Check the reading is –1000.00V ± 15 digits.

31) Switch the DC Calibrator to zero output. Remove the DC Calibrator.

2.2.3.3 Resistance

32) Apply a short circuit to the resistance input terminals. Select 1kΩ. Adjust R45 for an indication of .00000 ± 1 digit.

NOTE: If long leads to the precision resistors are to be used their resistance must be accounted for either by nulling out their lead resistance, i.e. by applying them as the short circuit in step 32 or, by calibrating the instrument high by the amount of measured lead resistance.

*33) Select 10, kΩ. Check the reading is 0.0000 ± 2 digits.

*34) Select 100, kΩ. Check the reading is 0.000 ± 2 digits.

*35) Select 1000, kΩ. Check the reading is 0.00 ± 1 digit.

*36) Select 10MΩ. Check the reading is 0.0000 ± 1 digit. Remove the short circuit from the input.

37) Select 10, kΩ. Apply the 10kΩ Standard Resistor (2.2.2.3) to the resistance input. Adjust R72 for a reading of 10.0000 ± 1 digit.

Remove the 10kΩ Standard Resistor.

38) Select 1, kΩ. Apply the 1kΩ Standard Resistor (2.2.2.3) to the resistance input. Adjust R15 for a reading of 1.00000 ± 2 digits.

Remove the 1kΩ Standard Resistor.

39) Select 100, kΩ. Apply the 100kΩ Standard Resistor (2.2.2.3) to the resistance input. Adjust R11 for a reading of 100.000 ± 2 digits.

Remove the 100kΩ Standard Resistor.

*40) Apply the 10kΩ Standard Resistor (2.2.2.3) to the resistance input. Check the reading is 10.000 ± 2 digits.

Remove the 10kΩ Standard Resistor.

*41) Apply the 1kΩ Standard Resistor (2.2.2.3) to the resistance input. Check the reading is 1.000 ± 1 digit.

Remove the 1kΩ Standard Resistor.

42) Select 1000, kΩ. Apply the 1MΩ Standard Resistor (2.2.2.3) to the resistance input. Adjust R7 for a reading of 1000.00 ± 3 digits.

43) Select 10MΩ. Adjust R84 for a reading of 1.0000 ± 5 digits.

Remove the 1MΩ Standard Resistor.

44) Apply the 10MΩ Standard Resistor (2.2.2.3) to the resistance input. Check the reading settles to 10.0000 ± 250 digits.

Remove the 10MΩ Standard Resistor.

45) If the instrument has been zeroed as described in step 32, with long leads:

Select 1, kΩ. Apply a short circuit link to the resistance input. Adjust R45 for an indication of .00000 ± 3 digits.

2.2.3.4. **AC Voltage**

*46) Select 1, ACV. Apply a short circuit to the voltage input terminals. Connect the Oscilloscope (2.2.2.5) set to 100mV/ division, to T.P.8 w.r.t. 'Lo'. Adjust R119 for an indication of zero.

NOTE: Due to the high gain of this non-linear circuit at zero, the output will appear very 'noisy' as zero is approached. The best zero is obtained when this noise is symmetrical about zero.

Remove the Oscilloscope.

*47) Connect the DC voltmeter (2.2.2.4) to T.P.9 w.r.t. 'Lo'. Adjust R131 to obtain a positive indication on the DC voltmeter of approximately +0.3V. (This should correspond to a minimum reading on the instrument's display).

*48) Connect the DC voltmeter to T.P.11 w.r.t. 'Lo'. Adjust R147 for an indication on the DC voltmeter of −1mV ± 0.1mV.

Remove the DC voltmeter.

*49) Connect the Oscilloscope (2.2.2.5) to T.P.12 w.r.t. 'Lo'. Adjust R150 for a 'noisy' zero.

Remove the Oscilloscope.

*50) Adjust R147 for a reading of .00000 ± 2 digits on the display.

Remove the short circuit from the voltage input.

*51) Connect the AC Calibrator (2.2.2.2) to the voltage input of the instrument. Apply 10mV r.m.s., 300Hz. Adjust R 131 for a reading of .00990 ± 3 digits.

Remove the AC Calibrator.

*52) Repeat step 46.

Remove the short circuit from the input.

53) Select 1, DCV + ACV. Connect the DC Calibrator (2.2.2.1) to the voltage input.

i) Apply +1.00000V. Note the reading.

ii) Apply −1.00000V. Adjust R126 for the same reading as obtained in 53(i) ± 20 digits.

Remove the DC Calibrator.

54) Select 1, ACV. Connect the AC Calibrator (2.2.2.2) to the voltage input. Apply 1V r.m.s. 300Hz. Adjust R157 for 1.00000 ± 10 digits.

Remove the AC Calibrator.

*55) Repeat in sequence given, steps 46, 51, 53 and 54 until all readings are correct without further adjustment.

56) Connect the AC Calibrator (2.2.2.2) to the voltage input. Apply 1.9V r.m.s., 300Hz. Check the reading is 1.90000 ± 100 digits.

57) Apply 100mV r.m.s., 300Hz. Check the reading is .10000 ± 50 digits.

58) Apply 1mV r.m.s., 300Hz. Check the reading is .00100 ± 50 digits.

Remove the AC Calibrator.

59) Apply short circuit input. Check the reading is .00000 ± 50 digits.

Remove the short circuit input.

60) Connect the AC Calibrator (2.2.2.2) to the voltage input. Apply 1V r.m.s., 30kHz. Adjust C40 for a reading of 1.00000 ± 10 digits.

61) Apply 1V r.m.s. at the following frequencies and check the response:–

3kHz: 1.00000 ± 50 digits.
300Hz: 1.00000 ± 20 digits.
40Hz: 1.00000 ± 50 digits.

CAUTION: High voltages may appear on the input attenuator trimmers C2, C4 and C7. Only an adjusting tool which has a totally insulated body (to higher than the maximum output voltage capability of the A.C. Calibrator, 2.2.2.2) should be used. DO NOT use an insulated handle screw driver.

62) Select 1000, ACV. Apply 700V r.m.s., 3kHz. Adjust C7 for a reading of 700.00 ± 10 digits.

63) Apply 100V r.m.s., 3kHz. Select 100, ACV. Adjust C4 for a reading of 100.000 ± 10 digits.

64) Apply 10V r.m.s. 3kHz. Select 10, ACV. Adjust C2 for a reading of 10.0000 ± 10 digits.

65) Repeat steps 62 63 and 64 until the specified reading is obtained at each step without further adjustment.

66) Select 1000, ACV. Apply 700V r.m.s. and check the frequency response at the following frequencies:

3kHz: 700.00 ± 100 digits.
300Hz: 700.00 ± 100 digits.
40Hz: 700.00 ± 100 digits.

If necessary, re-adjust C7 to give the best average accuracy over this band.

67) Apply 100V r.m.s. Select 100, ACV and check the frequency response at the following frequencies:

30kHz: 100.000 ± 200 digits.
3kHz: 100.000 ± 100 digits.
300Hz: 100.000 ± 100 digits.
40Hz: 100.000 ± 100 digits.

If necessary, re-adjust C4 to give the best averaged accuracy over this band.

68) Apply 10V r.m.s. Select 10, ACV and check the frequency response at the following frequencies:

30kHz: 10.0000 ± 200 digits.
3kHz: 10.0000 ± 100 digits.
300Hz: 10.0000 ± 100 digits.
40Hz: 10.0000 ± 100 digits.

If necessary, re-adjust C2 to give the best averaged accuracy over this band.

Remove the AC Calibrator.

This completes the routine calibration procedure and the covers should be secured.

2.3 REPAIR AND COMPONENT REPLACEMENT

2.3.1 General

IT IS RECOMMENDED THAT THIS SECTION BE NOTED BEFORE UNDERTAKING ANY REPAIR.

A fault in the analogue circuitry will require the internal Guard Shields removing for access to the components and subsequent recalibration. Digital integrated circuits are fitted in sockets and can be replaced without disturbing the calibration of the instrument (although it is advisable to verify the performance after any component change).

The method of manufacture evolved by DATRON to ensure high reliability and stability involves elevated temperature 'burn-in' at both component and instrument level. In addition, operational amplifiers and other devices are selected for certain parameters. Hence many of the components used, although originally of a standard type, have a performance which can only be identified by a DATRON part number. These devices are held as stock items by DATRON who should be contacted if replacement is necessary.

Replacement of certain active devices and precision resistors also necessitates the re-selection of their associated F.S.V. (Factory Selected Values) resistors to accommodate component tolerances. These resistors, often high stability, metal film types are used to preset an offset or reference setting, usually with fine adjustment provided by an associated potentiometer. Procedures for selecting these resistors are given in Section 2.3.2.

Replacement of analogue components should be followed by recalibration of the relevant part of the circuit as described in Section 2.3.2. Full routine calibration should then be carried out to ensure the instrument is within specification – if in any doubt consult our Customer Service Department.

When replacing semiconductor devices take great care to avoid overheating them during soldering . . . each joint being made as rapidly as possible. Although the use of a thermal shunt between semiconductor device and the soldered joint is strongly recommended, it is realised that it is impractical to use one in many instances . . . particularly when unsoldering a multi-lead device from a high density circuit board, a suction de-soldering tool is recommended.

When working on the isolator board, special consideration should be given to the effects of board leakage. Although active guarding is used extensively to reduce these effects, it should be borne in mind because of the high input impedance and sensitivity involved.

2.3.2 Adjustments following component replacement

These procedures should be carried out with all boards mounted in the instrument. Guard shields should be removed to enable F.S.V.'s to be changed where necessary. (This will make the instrument slightly more 'noisy' than in normal operation with the shields fitted).

Before proceeding with any adjustments, the instrument should be allowed a 30 minute 'warm-up' period after switch on.

NOTE:– A small amount of interaction exists between certain controls, also the adjustment of certain controls has an effect which may not be immediately noticeable, i.e. zero drift with temperature. The user is therefore warned not to follow blindly all the sequences described, but to read and understand the reason behind each procedure, before embarking upon any actual adjustments on his own account. This approach should minimize the amount of time spent on recalibration, and in a number of instances, will eliminate upsetting preset adjustments which are already correctly set.

When the necessary procedures have been completed, all F.S.V. resistors should be soldered in position, the guard shields re-fitted, the instrument covers placed, but not secured, in position, and a routine calibration carried out as specified in Section 2.2.

2.3.2.1 Special Test Equipment

High Crest Factor Signal

A precision pulse train of approximately 5:1 crest factor and 100Hz repetition frequency. The d.c. coupled output level to be 1V r.m.s. $\pm$ 0.05%.
NOTE:– This item is only required for the a.c. voltage procedure to set the linearity of the r.m.s. converter for a high crest factor signal. Advice on construction of a suitable piece of test equipment is available from our Customer Service Department.

2.3.3 **Analogue to Digital Converter Board – Assembly Drawing No. 400161.**

Adjustments and calibration are to the A–D Converter Board unless otherwise stated.

Equipment required is as specified in Sections 2.2.2.1, 2.2.2.4, 2.2.2.5, 2.2.2.6.

1) Set all preset potentiometers to the centre of their span.
In the case where Q1 has been replaced, remove the protection link on the device before switching power on. Select 1, DCV on the Analogue Board and apply short circuit to voltage input.

2) Connect the D.C. Voltmeter to T.P. 33 w.r.t. (with respect to) T.P. 39. Check the voltage is +5V ± 0.25V.

3) Connect the D.C. Voltmeter to T.P. 32 w.r.t. T.P. 39. Check the voltage is −8.2V ± 0.3V.

4) Connect the D.C. Voltmeter to the positive end of C108 w.r.t. T.P. 39. Check the voltage is 165V ± 20V.

5) Connect the D.C. Voltmeter to the output pad 6 at the rear of the board w.r.t. T.P. 19. Check the voltage is +15V ± 0.75V.

6) Connect the D.C. Voltmeter to the output pad 4 at the rear of the board w.r.t. T.P. 19. Check the voltage is −15V ± 0.75V.

7) Connect the D.C. Voltmeter to T.P.12 w.r.t. T.P.19. Check the voltage is −10V ± 1V.

8) Connect the D.C. Voltmeter to T.P.4 w.r.t. T.P.19. Check the voltage is +11V ± 0.5 V.

9) Connect the D.C. Voltmeter to T.P.2 w.r.t. T.P.19. Check the voltage is −5V +0V, -0.25V.

10) Connect the D.C. Voltmeter to T.P.3 w.r.t. T.P.19. Check the voltage is +5V +0.25V, -0V.

11) Connect the Oscilloscope to M47 input (pin nearest rear of board) w.r.t. T.P.19. Check for 100Hz ripple (not 50Hz – i.e. the rectifier bridge, W2, is working correctly).

12) Connect the Oscilloscope to M48 input (pin nearest rear of board) w.r.t. T.P.19. Check for 100Hz ripple (not 50Hz – i.e. the rectifier bridge, W3, is working correctly).

13) Connect the Oscilloscope to M50 input (pin nearest rear of board) w.r.t. T.P.39. Check for 100Hz ripple (not 50Hz – i.e. the rectifier bridge, W1, is working correctly).

14) Connect the Oscilloscope to T.P.23 w.r.t. T.P.39. Check for clock pulses of approximately 2 μS period, 5V amplitude.

15) Connect the Frequency Counter to T.P.23 w.r.t. T.P.39. Adjust R112 to produce a clock frequency of 500kHz ± 100Hz.

16) Connect the Oscilloscope to M21, 6 w.r.t. T.P.39. Check for 'Command' pulses of approximately 100 μS duration and repetition frequency of 3/second. These should be of approximately 5V amplitude.

17) Connect the Oscilloscope to T.P.24 w.r.t. T.P.39. Check for 'Sig' pulses, negative going, of 20mS duration. These should be of approximately 5V amplitude.

18) Connect the Oscilloscope to T.P.11 w.r.t. T.P.19. Check for 'Sig' pulses, negative going, of 20mS duration. These should be of approximately 30V amplitude.

19) Cut link from M.28/1 to M.28/9. Check that 'Sig' pulses observed in step 19 disappear and the voltage at T.P.11 is steady at approximately +15V (i.e. the analogue section of the A–D Converter is in the 'Reset' condition).

20) Connect the Oscilloscope to T.P.1 w.r.t. T.P.19. Adjust R3 for less than 50mV. (Allow sufficient time for 'Reset' to come out of saturation).

21) Connect the Oscilloscope to T.P.10 w.r.t. T.P.19. Adjust R82 to produce a noisy signal of amplitude from 0V to +15V.

22) Connect the Oscilloscope to T.P.28 w.r.t. T.P.39. Check for a noisy signal, similar to that obtained in step 21, of 5V amplitude.

23) Connect the Oscilloscope to T.P.9 w.r.t. T.P.19. Check the wideband noise level and 100Hz content is less than 400mV peak to peak. (A reduction in the 100Hz content may be achieved by slackening the mounting screw and rotating the mains transformer, T4, if noise is in excess of 400mV peak to peak).

24) Reconnect link from M28/1 to M28/9. The display on the instrument should read all zeros ± 30 digits. Adjust R82 for a display of ± .00000, bouncing polarity. If it is not possible to achieve this, then it is acceptable to set R82 for bouncing polarity only (e.g. +4 bouncing to −3).

25) Select:

(a) All 'Ranges' in turn. Check:–

(i) When '1' (DCV) is selected that d.p.1 is 'on' i.e. the display is ± .0000X (X need not be zero).

(ii) When '10' is selected that d.p.2 is 'on' i.e. the display is ± 0.000X.

(iii) When '100' is selected that d.p.3 is 'on' i.e. the display is ± *0.00X (* represents leading zero digit which is 'off').

(iv) When '1000' is selected that d.p.4 is 'on' i.e. the display is ± **0.0X.

(b) 100mV D.C. Check as (a) (iii).

(c) 10MΩ. Check as (a) (ii).

26) Select all 'Functions' in turn and check that the polarity sign is only displayed in the D.C. functions.

27) Switch to 1, DCV. Apply a d.c. input signal of greater than 2V and check that the display blanks without leaving any digit segments or decimal points glowing ('keep-alive' cathodes will still be illuminated but these should be masked by tape).

28) Apply +1.9V to the input terminals. Check that the display segments are of equal brightness and free from 'streamers' (ionization of display where not required).

29) Apply short circuit input. Select 1, DCV. Adjust R82 for .0000X, bouncing polarity.

30) Apply +1V. Select, F.S.V. resistors R70 and R71 to obtain a display of +1.00000 ± 20 digits (if value of R70 or R71 is less than 1MΩ, use 50ppm/°C metal film resistors).

31) Apply −1V. Select F.S.V. R43 (typically 3M3) and adjust R78 for a display of −1.000000 ± 20 digits.

32) Recheck step 29.

33) Apply +100 μV. Adjust R80 to produce a display of +.00009 to +.00010.

NOTE. If the span of R80 is insufficient, return R80 to mid-travel and select F.S.V. R94 to produce a display of +.00010 ± 3 digits, then use R80 to produce a display of +.00009 to +.00010.

34) Apply +1mV. Adjust R46 to produce a display of +.00100 ± 1 digit.

35) Repeat steps 32 to 34 until no further adjustment is necessary.

36) Apply −100 μV. Adjust R81 for a display of −.00009 to +.00010.

37) Apply short circuit input. Check that the display reads zero ± 1 digit.

38) Apply short circuit input. Select 10, DCV. Adjust R38 'pA' offset control on front panel of instrument for ± 0.0000,bouncing polarity.

39) Select 100mV D.C. Adjust R54 ' μV' offset control on front panel of instrument for ± 0.000, bouncing polarity.

40) Select 1, DCV. Adjust R82 for a reading of ± .00000, bouncing polarity.

41) Repeat steps 38, 39 and 40 until the instrument reads zero in all ranges without further adjustment.

42) Repeat steps 33, 34, 36 and 40 until all readings are correct without any further adjustment.

43) Apply +1V. Adjust R76 for a reading of +1.00000 ± 2 digits.

44) Apply −1V. Adjust R78 for a reading of −1.00000 ± 2 digits.

45) Apply +1.9V. Check the reading on the display is (reading in step 43 x 1.9) ± 6 digits.

46) Apply −1.9V. The reading on the display should be (reading in step 44 x 1.9) ± 6 digits.

47) Apply short circuit input. Check the display for noise at zero. This should be less than ½ digit, e.g. .00001 bouncing .00002.

48) Apply +1V. Check the display for noise at 1V. This should be less than 1 digit, e.g. +1.00000 through +1.00001 to +1.00002.

49) Apply +1.9V. Check the display for noise at 1.9V. This should be less than 1 digit, e.g. +1.90002 through +1.90003 to +1.90004.

2.3.4 Analogue Board – Assembly Drawing No. 400158.

Adjustments and calibration are to the Analogue Board unless otherwise stated.

2.3.4.1 Preliminary Checks

1) Select all 'Functions' in turn. Check:–

   a) The polarity sign on the display is displayed in the following 'Functions' only: 100mV DC and DCV.

   b) In 100mV DC check d.p. (decimal point) 3 is 'on', (Instruments display) and the 'mV' indicator is on.

   c) In 10MΩ check d.p. 2 is 'on' and the 'MΩ' indicator is on.

   d) In DCV and ACV the 'V' indicator is on.

   e) In kΩ the 'kΩ' indicator is on.

2) Select DCV, then select all 'Ranges' in turn. Check:–

   a) When '1' is selected, check d.p. 1 is 'on'.

   b) When '10' is selected, check d.p. 2 is 'on'.

   c) When '100' is selected, check d.p. 3 is 'on'.

   d) When '1000' is selected, check d.p. 4 is 'on'.

2.3.4.2 DC Voltage

Equipment required is as specified in Sections 2.2.2.1, 2.2.2.4, 2.2.2.5.

1) Select 1, DCV. Apply short circuit to the voltage input terminals. Check the bootstrapped supplies are present at T.P. (test point) 3 (+10V) and T.P.5 (−10V) w.r.t. (with respect to) T.P.15 (signal common).

   Check the supplies do not oscillate with the Oscilloscope.

2) Check with Oscilloscope no oscillation occurs at T.P.6 when the following are selected: 100mV DC; 1, DCV; 10, DCV.

3) Select 100mV DC. Short together the pins marked 'GND 1/P' on the analogue board. Connect the DC Voltmeter to T.P.2 w.r.t. T.P.15 and adjust R68 for an indication of zero ± 20 μV on the DC Voltmeter. Remove the DC Voltmeter.

4) Set the ' μV' offset potentiometer, R54 on the front panel of the instrument to the centre of its span. Set the instruments display to 0.000 ± 20 digits by selection of F.S.V. resistors R50, R51 and a link between R50 and +BS or –BS. Use metal film resistors (50ppm/°C) if total resistance of R50 and R51 is below 1MΩ.

5) Adjust R54 for an indication of 0.000, bouncing polarity.

6) Remove the short circuit from the 'GND 1/P' pins and replace with a short across the voltage input terminals.

7) Select 10, DCV. Adjust the 'pA' offset control, R38 on the front panel of the instrument for 0.0000, bouncing polarity.

8) Select 100mV DC. Adjust ' μV' offset R54 for an indication of 0.000, bouncing polarity.

9) Select 1, DCV. Adjust R82 (on the A–D Converter) for .00000, bouncing polarity.

10) Repeat steps 7, 8 and 9 until the instrument reads zero at all steps without further adjustment.

11) Select 1, DCV. Apply +.00010V, adjust R80 ('+F/F' on the A–D Converter) for +9, bouncing +10 digits.

12) Apply –.00010V, adjust R81 ('–F/F' on the A–D Converter) for –9, bouncing –10 digits.

13) Apply +.00100V, adjust R46 ('100 digits' on the A–D Converter) for +100 digits.

14) Apply S/C input. Check reading is .00000, bouncing polarity. If not, repeat steps 7–13.

15) Apply +1.00000V, adjust R76 ('+1V' on the A–D Converter) for +1.00000 ± 1 digit.

16) Apply –1.00000V, adjust R78 ('–1V' on the A–D Converter) for –1.00000 ± 1 digit.

17) Apply +1.90000V. Check reading is +1.90000 ± 6 digits.

18) Apply –1.90000V. Check reading is –1.90000 ± 6 digits.

19) Apply short circuit input and repeat step 8.

20) Apply +100.000mV. Adjust R65 for +100.000 ± 2 digits.

21) Apply –100.000mV, check instrument reads –(reading obtained in step 20) ± 6 digits.

NOTE: If changing polarity involves reversing leads, check zero again as thermal e.m.f.'s may have changed. If possible, reverse polarity at a higher potential, i.e. through an attenuator, so as not to change thermals.

22) Select 10, DCV. Apply +10.0000V, adjust R13 for +10.0000 ± 1 digit.

23) Apply –10.0000V, check reading is –10.0000 ± 4 digits.

24) Select 100, DCV. Apply +100.000V, adjust R9 for +100.000 ± 1 digit.

25) Apply –100.000V, check reading is –100.000 ± 4 digits.

26) Select 1000, DCV. Apply +500.00V, adjust R5 for +500.00 ± 1 digit.

27) Apply +1000.00V, check reading is +1000.00 ± 15 digits.

NOTE: When applying 1000V:

i) Check the DC Calibrator (2.2.2.1) does not exhibit excessive overshoot (i.e. <10%) when the 1000V range is selected. If in doubt, or if overshoot is excessive, increase output from calibrator gradually in 100V steps. Transients exceeding the maximum working voltage of the instrument may cause internal damage.

ii) Switch to zero before applying the opposite polarity since a 2000V edge (i.e. from +1000V to –1000V) may damage the instrument.

iii) Take care to ensure that 1000V does not appear between input 'Lo' and earth; if in any doubt apply 500V.

28) Apply –1000.00V, check the reading –1000.00 ± 15 digits.

2.3.4.3. Resistance

Equipment required is as specified in Section 2.2.2.3.

1) Apply S/C to resistance input terminals. Select 1kΩ and adjust R45 for .00000 ± 3 digits.

NOTE: If long leads to the precision resistors are to be used their resistance must be accounted for either by nulling out their lead resistance, i.e. by applying them as the S/C in step 1 or by calibrating the instrument high by the amount of measured lead resistance.

2) Select 10, kΩ. Check reading is zero ± 2 digits.

3) Select 100, kΩ. Check reading is zero ± 2 digits.

4) Select 1000, kΩ. Check reading is zero ± 1 digit.

5) Select 10MΩ. Check reading is zero ± 1 digit.

6) Apply 10kΩ to resistance input terminals. Select 10, kΩ. Set R72 to the centre of its span and select R73 F.S.V. for 10.0000 ± 50 digits. Use a metal film resistor (<50ppm/^{o}C) for R73.

7) Adjust R72 for a reading 10.0000 ± 1 digit.

8) Select 1, kΩ. Apply 1kΩ, adjust R15 for 1.00000 ± 2 digits.

9) Select 100, kΩ. Apply 100kΩ, adjust R11 for 100.000 ± 2 digits.

10) Apply 10kΩ, check reading is 10.000 ± 2 digits.

11) Apply 1kΩ, check reading is 1.000 ± 2 digits.

12) Select 1000 kΩ. Apply 1MΩ, adjust R7 for 1000.00 ± 5 digits.

13) Select 10MΩ. Apply 1MΩ, adjust R84 for 1.0000 ± 5 digits.

14) Apply 10MΩ, check reading is 10.0000 ± 200 digits.

2.3.4.4 AC Voltage

DC checks:–

Equipment required is as specified in Sections 2.2.2.1, 2.2.2.4, 2.2.2.5 and a High Crest Factor Signal as specified in Section 2.3.2.1.

1) Select 1, ACV. Apply S/C to input. Connect the DC Voltmeter to T.P.6 w.r.t. T.P.15. Select R107 and R108 for an indication on the DC Voltmeter of zero ± 500 μV. Note the reading.

2) Select 1, DCV + ACV. Check the output at T.P.6 on the DC Voltmeter does not differ from the reading in step 1 by more than ± 150 μV.

3) Apply short circuit input. Connect the Oscilloscope (set to 100mV/division) to T.P.8 w.r.t. T.P.15 and adjust R119 for an indication of zero.

NOTE: Due to the high gain of this non-linear circuit at zero the output will appear very 'noisy' as zero is approached. The best zero is obtained when this noise is symmetrical about zero.

4) Connect the DC Voltmeter to T.P.9 w.r.t. T.P.15. Adjust R131 to obtain a positive reading which should be approximately +0.3V. (If necessary use F.S.V. resistors R130 and R133 selected so that the d.c. voltmeter just reads positive (+0.3V) with R131 set at the centre of its span.

5) Connect the DC Voltmeter to T P.11 w.r.t. T.P.15. Adjust R147 for an indication of −1mV ± 0.1mV.

6) Connect the Oscilloscope (set to 100mV/division) to T.P.12 w.r.t. T.P.15. Adjust R150 for 'noisy' zero.

7) Adjust R147 for an indication on the instruments display of zero ± 3 digits.

8) Apply +10mV. Adjust R131 for .00990 ±5 digits.

9) Repeat step 3.

10) Set R126, R138 and R157 to the centre of their spans.

(a) Apply +1V and note the reading on the display.

(b) Apply −1V and select F.S.V. R124 for the same reading obtained in 10(a) ± 800 digits. Adjust R126 to obtain the same reading ± 10 digits.

11) Apply +1V. Select F.S.V. R155 for an indication of 1.00000 ± 400 digits. Adjust R157 for 1.00000 ± 10 digits.

12) Apply the High Crest Factor signal of 1V r.m.s. (2.3.2.1). Adjust R138 for 1.00000 ± 20 digits.

13) Repeat in sequence given, steps 11, 12, 3, 8, 3, 10, 11 and 12 until all readings are correct without any further adjustment.

14) Apply +1.9V. Select F.S.V. R143 for 1.90000 ± 50 digits.

15) Repeat steps 11 and 14 until the readings are correct without further adjustment.

16) Repeat steps 3, 8, 10, 11, 12 and 14, until all readings are correct without further adjustment.

17) Apply −1.9V. Check the reading is 1.90000 ± 100 digits.

18) Select 10, DCV + ACV. Apply +10V, check the reading is 10.0000 ± 50 digits.

AC Checks:–

Equipment is as specified in Section 2.2.2.2.

19) Select 1, ACV. Apply 1V r.m.s., 300Hz. Adjust R157 for 1.00000 ± 10 digits.

20) Apply 1V r.m.s., 30kHz. Adjust C40 for 1.00000 ± 10 digits.

21) Apply 1V r.m.s. at the following frequencies and check the response:–

3kHz: 1.00000 ± 50 digits.
300Hz: 1.00000 ± 20 digits.
40Hz: 1.00000 ± 50 digits.

CAUTION: High voltages may appear on the input attenuator trimmers C2, C4 and C7. Only an adjusting tool which has a totally insulated body (to higher than the maximum output voltage capability of the A.C. Calibrator, 2.2.2.2.) should be used. DO NOT use an insulated handle screw driver.

22) Select 1000, ACV. Apply 100V r.m.s. 3kHz, adjust C7 for 100.00 ± 10 digits.

23) Select 100, ACV. Apply 100V r.m.s. 3kHz, adjust C4 for 100.000 ± 10 digits.

24) Select 10, ACV. Apply 10V r.m.s. 3kHz, adjust C2 for 10.0000 ± 10 digits.

25) Repeat steps 22, 23 and 24 until the specified reading is obtained at each step, without further adjustment.

26) Select 100, ACV. Apply 100V r.m.s. and check the frequency response, at the following frequencies:–

30kHz: ± 200 digits
3kHz: ± 100 digits
300Hz: ± 100 digits.
40Hz: ± 100 digits.

If necessary, readjust C4 to achieve best average accuracy over the frequency range.

27) Select 10, ACV. Apply 10V r.m.s. and check the frequency response as in step 26.

If necessary, readjust C2 to achieve best average accuracy over the frequency range.

NOTE: If the frequency response is correct on the 10V and 100V range it is unlikely that the 1000V range will have a response problem. Application of voltages above 100V with no guard shields fitted may cause the current protection trip to operate.

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R1		NOT USED			–
R2		"			–
R3	000182	1K8 5% ¼W CARBON	MULLARD	CR25	1
R4	000823	82K " " "	"	"	1
R5	063503	50K POT CERMET	BECKMAN	72P	2
R6	000103	10K 5% ¼W CARBON	MULLARD	CR25	15
R7	063503	50K POT CERMET	BECKMAN	72P	–
R8	000822	8K2 5% ¼W CARBON	MULLARD	CR25	2
R9	063502	5K POT CERMET	BECKMAN	72P	3
R10	000821	820R 5% ¼W CARBON	MULLARD	CR25	1
R11	063502	5K POT CERMET	BECKMAN	72P	–
R12	000122	1K2 5% ¼W CARBON	MULLARD	CR25	2
R13	063202	2K POT CERMET	BECKMAN	72P	1
R14	000822	8K2 5% ¼W CARBON	MULLARD	CR25	–
R15	063502	5K POT CERMET	BECKMAN	72P	–
R16	000103	10K 5% ¼W CARBON	MULLARD	CR25	–
R17	000112	1K1 " " "	"	"	2
R18	000112	1K1 " " "	"	"	–
R19	000100	10R " " "	"	"	1
R20	000121	120R " " "	"	"	1
R21		SEE SWITCH BOARD ASSY.	P/L 400		–
R22		" " " "	" "		–
R23		NOT USED			–

NOTES.

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ISS.	A	B	C	D	1	2			
	—	—	ECO 304	ECO 305	ECO 346	ECO 343			
	7-6-76	24-6-76	24-8-76	20.10.76	1.11.76	29.11.76			

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R24	000104	100K 5% ¼W CARBON	MULLARD	CR25	12
R25		SLEEVED LINK			1
R26	000113	11K 5% " "	"	"	1
R27	000103	10K " " "	"	"	—
R28		NOT USED			—
R29		"			—
R30	003223	22K " 2W "	ALLEN BRADLEY	HB	8
R31	003223	22K " " "	"	"	—
R32	003223	22K " " "	"	"	—
R33	003223	22K " " "	"	"	—
R34	000204	200k 5% ¼W "	MULLARD	CR25	1
R35		NOT USED			—
R36	000476	47M " " "	ALLEN BRADLEY	CB10	2
R37	000224	220K 5% " "	MULLARD	CR25	1
R38	064105	1M POT MULTI-TURN	BECKMAN	89P	2
R39	000335	3M3 10% ¼W CARBON	MULLARD	CR25	2
R40	000106	10M " " "	"	"	3
R41	000103	10K 5% " "	"	"	—
R42, R43	440023	F.S.V. (100K 1% MF)	WELWYN	4033C	1 KIT
					—
R44	000223	22K 5% ¼W CARBON	MULLARD	CR25	2
R45	063203	20K POT CERMET	BECKMAN	72P	1
R46	000393	39K 5% ¼W CARBON	MULLARD	CR25	1

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R47	000474	470K 5% ¼W CARBON	MULLARD	CR25	4
R48	000335	3M3 10% " "	"	"	—
R49	000102	1K 5% " "	"	"	1
R50, R51	440024	F.S.V. (1M-10M 1% MF)	WELWYN	4033C	1 KIT
					—
R52	000474	470K 5% ¼W CARBON	MULLARD	CR25	—
R53	000474	470K " " "	"	"	—
R54	064105	1M POT MULTI-TURN	BECKMAN	89P	—
R55	000474	470K 5% ¼W CARBON	MULLARD	CR25	—
R56	000512	5K1 " " "	"	"	1
R57	000333	33K " " "	"	"	1
R58	000226	22M 10% " "	ALLEN BRADLEY	CB10	1
R59		NOT USED			—
R60		"			—
R61		"			—
R62	090020	20K/2k2 MATCHED PAIR	MANN	M250/A	1 PAIR
R64	090020	0·1% W/W			—
R63	000275	2M7 10% ¼W CARBON	MULLARD		1
R65	063100	10R POT CERMET	BECKMAN	72P	2
R66	000103	10K 5% ¼W CARBON	MULLARD	CR25	—
R67	000103	10K " " "	"	"	—
R68	063104	100K POT CERMET	BECKMAN	72P	1
R69	000473	47K 5% ¼W CARBON	MULLARD	CR25	1

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R70	000273	27K 5% ¼W CARBON	MULLARD	CR25	3
R71	090021	4K7/4k4 MATCHED PAIR	MANN	250/A	1 PAIR
R74	090021	0·1% W/W			–
R73		F.S.V. (150K-470K)	MULLARD	CR25	1
R72	063100	10R POT CERMET	BECKMAN	72P	–
R75	090022	2K4/10k MATCHED PAIR	MANN	250/A	1
R79	090022	0·1% W/W			
R77	000104	100K 5% ¼W CARBON	MULLARD	CR25	–
R78	000103	10K " " "	"	"	–
R76	000562	5k6 5% ¼W CARBON	MULLARD	CR25	1
R80	011052	10K5 1% ⅛W M/F	WELWYN/HOLCO	4033C/H4	1
R81	011201	1K2 " " "	" "	" "	1
R82	000273	27K 5% ¼W CARBON	MULLARD	CR25	–
R83	000103	10K " " "	"	"	–
R84	063500	50R POT CERMET	BECKMAN	72P	2
R85	000103	10K 5% ¼W CARBON	MULLARD	CR25	–
R86	000472	4K7 " " "	"	"	2
R87	000123	12K " " "	"	"	1
R88	000302	3K " " "	"	"	1
R89	000103	10K " " "	"	"	–
R90	003223	22K 10% 2W "	ALLEN BRADLEY	HB	–
R91	003223	22K " " "	"	"	–
R92	003223	22K " " "	"	"	–

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R93	003223	22K 10% 2W CARBON	ALLEN BRADLEY	HB	–
R94	000105	1M " 1/4W "	MULLARD	CR25	3
R95	000364	360K 5% " "	"	"	1
R96		F.S.V. (4M7-100M)	MULLARD / A.B.	CR25 / CB10	1
R97		F.S.V. (4M7-100M)	" "	" "	1
R98	000334	330K 5% 1/4W CARBON	MULLARD	CR25	1
R99	000565	5M6 10% " "	"	"	1
R100	000107	100M " " "	ALLEN BRADLEY	CB10	2
R101	000104	100k 5% " "	MULLARD	CR25	–
R102		NOT USED			
R103	000331	330R 5% 1/4W CARBON	"	"	1
R104		NOT USED			–
R105		NOT USED			–
R106		NOT USED			–
R107		F.S.V. (1K - 470K)	MULLARD	CR25	1
R108		F.S.V. (1K - 470K)	"	"	1
R109	000273	27K 5% 1/4W CARBON	"	"	–
R110	000163	16K " " "	"	"	1
R111	000105	1M 10% " "	"	"	–
R112	000202	2K 5% " "	"	"	1
R113	000105	1M 10% " "	"	"	–
R114		NOT USED			–
R115		"			–

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SHEET 6 OF –

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R116		NOT USED			–
R117	014701	4K7 1% 1/8W M/F	WELWYN/HOLCO	4033C/H4	2
R118	000472	4K7 5% 1/4W CARBON	MULLARD	CR25	–
R119	063105	1M POT CERMET	BECKMAN	72P	1
R120	000685	6M8 5% 1/4W CARBON	MULLARD	CR25	1
R121	014701	4K7 1% 1/8W M/F	WELWYN / HOLCO	4033C/H4	–
R122	000103	10K 5% 1/4W CARBON	MULLARD	CR25	–
R123	000122	1K2 " " "	"	"	–
R124		F.S.V. (470K – 4M7)	"	"	1
R125	011002	10K 1% 1/8W M/F	WELWYN/HOLCO	4033C/H4	2
R126	063101	100R POT CERMET	BECKMAN	72P	2
R127	012002	20K 1% 1/8W M/F	WELWYN/HOLCO	4033C/H4	2
R128	000107	100M 10% 1/4W CARBON	ALLEN BRADLEY	CB10	–
R129	000332	3K3 5% " "	MULLARD	CR25	1
R130		FSV (4M7 – 10M)	"	"	1
R131	063205	2M POT CERMET	BECKMAN	72P	3
R132	000476	47M 10% 1/4W CARBON	ALLEN BRADLEY	CB10	–
R133		F.S.V. (4M7 – 10M)	MULLARD	CR25	1
R134	000222	2K2 5% 1/4W CARBON	"	"	2
R135	000203	20K " " "	"	"	1
R136		FSV (SUPPLIED IN 290025 KIT)			–
R137	000270	27R 5% 1/4W CARBON	MULLARD	CR25	1
R138	063500	50R POT CERMET	BECKMAN	72P	–

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R139	000223	22K 5% 1/4W CARBON	MULLARD	CR25	–
R140	000104	100K " " "	"	"	–
R141	000396	39M 10% " "	ALLEN BRADLEY	CB10	1
R142	000108	1R 5% " "	MULLARD	CR25	1
R143	000563	FSV (39K-75K) FIT 56K ON ASSY.	"	"	1
R144	000104	100K 5% 1/4W CARBON	"	"	–
R145	000392	3K9 " " "	"	"	1
R146	011003	100K 1% 1/8W M/F	WELWYN/HOLCO	4033C/H4	3
R147	063205	2M POT CERMET	BECKMAN	72P	–
R148	000106	10M 10% 1/4W CARBON	MULLARD	CR25	–
R149	000222	2K2 5% " "	"	"	–
R150	063205	2M POT CERMET	BECKMAN	72P	–
R151	000106	10M 10% 1/4W CARBON	MULLARD	CR25	–
R152	000104	100K 5% " "	"	"	–
R153	011003	100K 1% 1/8W M/F	WELWYN/HOLCO	4033C/H4	–
R154	014302	43K " " "	" "	" "	1
R155		F.S.V. (390K-3M9)	MULLARD	CR25	1
R156	011002	10K 1% 1/8W M/F	WELWYN/HOLCO	4033C/H4	–
R157	063101	100R POT CERMET	BECKMAN	72P	–
R158	000103	10K 5% 1/4W CARBON	MULLARD	CR25	–
R159	000103	10K " " "	"	"	–
R160	000104	100K " " "	"	"	–
R161	000104	100K " " "	"	"	–

NOTES.

J.W. 1164

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DRAWING NUMBER 400158

SHEET 8 OF —

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R162	000104	100K 5% ¼W CARBON	MULLARD	CR25	–
R163	000104	100K " " "	"	"	–
R164		NOT USED			–
R165	000103	10K 5% ¼W CARBON	MULLARD	CR25	–
R166	000104	100K " " "	"	"	–
R167		NOT USED			–
R168	000104	100K 5% ¼W CARBON	MULLARD	CR25	–
R169		NOT USED			–
R170		"			–
R171		"			–
R172		"			–
R173		"			–
R174		"			–
R175		"			–
R176	000103	10K 5% ¼W CARBON	MULLARD	CR25	–
R177		NOT USED			–
R178	011003	100K 1% ⅛W M/F	WELWYN/HOLCO	4033C/H4	–
R179	012002	20K " " "	" "	" "	–
R180 *	000336	33M 10% ¼W CARBON	ALLEN BRADLEY	CB10	1 *
R181 *	000107	100M " " "	" "	"	1 *
R182	000272	2K7 5% " "	MULLARD	CR25	1

NOTES. * ONLY REQUIRED WHEN ANI ALTERNATIVE 090016 IS USED

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
C1	130057	210pF 1% 630v POLYSTY.	SUFLEX	HSS	1
C2	140007	15pF TRIMMER	JACKSON	TETFER VPC	4
C3	130058	220pF 1% 630v POLYSTY.	SUFLEX	HSS	1
C4	140007	15pF TRIMMER	JACKSON	TETFER VPC	–
C5	130042	100pF 1% 630v POLYSTYRENE	SUFLEX	HS	1
C6	130041	1000pF " " "	"	"	1
C7	140007	15pF TRIMMER	JACKSON	TETFER VPC	–
C8 *	102108	1pF 500V CER. DISC.	ERIE	861	1 *
C9	130043	11·1nF 1% 630v POLYSTYRENE	SUFLEX	HS	1
C10	130046	0·1µF " " "	"	"	1
C11		NOT USED			–
C12	110013	0·1µF 10% 250v POLYESTER	MULLARD	C280AEP100K	2
C13	102228	2p2 500V CER. DISC.	ERIE	831	3
C14	102228	2p2 " " "	"	"	–
C15	150014	·68µF 20% 35V DIP. TANT.	UNION CARBIDE	KR68E35	1

NOTES. * ONLY REQUIRED WHEN ANI ALTERNATIVE 090016 IS USED

J. W. 1164

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SHEET 10 OF —

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
C16		NOT USED			–
C17	140010	·22pF 10% 400V POLYPROP.	WIMA	MKP10	1
C18					
C19	140011	100nF " " "	"	"	1
C20	102228	2p2 500V CER. DISC.	ERIE	831	–
C21	102471	470pF " " "	"	801	2
C22	102471	470pF " " "	"	"	–
C23	110013	·1pF 10% 250v POLYEST.	MULLARD	C280AE/P100K	–
C24 *	102330	33pF 500v CER. DISC.	ERIE	801	1*
C25	102330	33pF " " "	"	"	1
C26 *	102330	33pF " " "	"	"	1 *
C27 *	102330	33pF " " "	"	"	1 *
C28	150001	22µF 20% 16V DIP. TANT.	UNION CARBIDE	K22E16	2
C29	150001	22µF " " " "	"	"	–
C30	130017	27pF 630v POLYSTYRENE	SUFLEX	HS	3
C31	130017	27pF " "	"	"	–
C32	120001	·22µF 10% 1000v POLYCARB.	"	SN1380	1
C33	110009	1µF 10% 100v POLYEST.	WIMA	MKS	1
C34	102108	1pF 500V CER. DISC.	ERIE	861	1
C35	101103	10nF 250v " "	"	801	2
C36	102680	68pF 500V " "	"	"	1
C37	150010	·33µF 20% 35v DIP. TANT.	UNION CARBIDE	KR33E35	2
C38	102470	47pF 500v CER. DISC.	ERIE	801	1

NOTES. *C24, C26 & C27 ONLY REQUIRED WHEN M13, M14 & M12 ALTERNATIVE TYPE 301 IS USED.

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
C39	110005	10nF 10% 250v POLYEST.	MULLARD	C280AE/P10K	1
C40	140007	15pF TRIMMER	JACKSON	TETFER VPC	–
C41	130044	820pF 10% 160v POLYSTY.	SUFLEX	HS	1
C42	102101	100pF 500v CER. DISC.	ERIE	801	4
C43	102478	4p7 " " "	"	831	2
C44	101103	10nF 250v " "	"	801	–
C45	102100	10pF 500v " "	"	"	1
C46	102101	100pF " " "	"	"	–
C47	102478	4p7 " " "	"	831	–
C48	150010	.33µF 20% 35V DIP. TANT.	UNION CARBIDE	KR33E35	–
C49	102220	22pF 500v CER. DISC.	ERIE	801	1
C50	102101	100pF " " "	"	"	–
C51	:10001	10pF 10% 16V P.E.T.P. FILM	ADVANCE	MD50A	1
C52	110022	2µ2 10% 63v " "	"	MD30A	1
C53	102101	100pF 500v CER. DISC.	ERIE	801	–
C54	110019	4µ7 10% 63V P.E.T.P. FILM	ADVANCE	MD40A	1
C55 *	102220	22pF 500v CER. DISC.	ERIE	801	1 *
C56		NOT USED			–
C57		SEE SWITCH BOARD ASSY.	P/L 400		–
C58		" " " "	" "		–
C59 *	102221	220pF 500v CER. DISC.	ERIE	801	1 *
C60	130017	27pF 630v POLYSTYRENE	SUFLEX	HS	–

NOTES. * ONLY REQUIRED WHEN AN1 ALTERNATIVE 090016 IS USED

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
D1	210056	ZENER 5V6 400mW	FAIRCHILD	BZY88C5V6	2
D2	210056	" " "	"	"	–
D3	210150	" 15V "	"	BZY88C15	1
D4	200008	Si LOW LEAKAGE	"	1N458A	6
D5	200008	Si " "	"	"	–
D6	200008	Si " "	"	"	–
D7	200008	Si " "	"	"	–
D8		NOT USED			–
D9	200001	Si G.P.		1N4148	10
D10	200001	Si "		"	–
D11	200001	Si "		"	–
D12		NOT USED			–
D13		"			–
D14		"			–
D15		"			–
D16		"			–

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SHEET 13 OF —

J. W. 1164

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
D17		NOT USED			–
D18		"			–
D19		"			–
D20	210033	ZENER 3V3 400mW	FAIRCHILD	BZY88C3V3	2
D21	210033	" " "	"	"	–
D22	200001	Si G.P.		IN4148	–
D23	200001	Si "		"	–
D24	200001	Si "		"	–
D25	200001	Si "		"	–
D26		NOT USED			–
D27	200001	Si G.P.		IN4148	–
D28	210075	ZENER 7v5 400mW	FAIRCHILD	BZY88C 7v5	2
D29	210075	" " "	"	"	–
D30	220001	Si HOT CARRIER	HEWLETT PACKHARD	5082-2800	2
D31	220001	Si " "	"	"	–
D32	200008	Si LOW LEAKAGE	FAIRCHILD	IN458A	–
D33	200008	Si " "	"	"	–
D34		NOT USED			–
D35		"			–
D36		"			–
D37	200001	Si G.P.		IN4148	–
D38	200001	Si "		"	–

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SHEET 14 OF

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
Q1		NOT USED			–
Q2		"			–
Q3		"			–
Q4		"			–
Q5	250004	Si " "		"	1
Q6	230002	N FET SWITCH G.P.	TELEDYNE	U1994E/K4416-18	5
Q7	230002	" " " "	"	"	–
Q8		NOT USED			–
Q9.	250006	Si PNP G.P.		BC322	1
Q10	230002	N FET SWITCH G.P.	TELEDYNE	U1994E/K4416-18	–
Q11		NOT USED			–
Q12		"			–
Q13		"			–
Q14	230002	N FET SWITCH G.P.	TELEDYNE	U1994E/K4416-18	–
Q15	230002	" " " "	"	" "	–
Q16		NOT USED			–
Q17		"			–
Q18	250001	Si PNP G.P.		BC214K	1

NOTES.

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
M1	280022	QUAD BILATERAL SWITCH	RCA	CD4016A	3
M2	280022	" " "	"	"	—
M3	280023	" 2 I/P NOR GATE	"	CD 4001A	4
M4	280017	HEX INVERTER	"	CD 4069B	1
M5	280023	QUAD 2 I/P NOR GATE	"	CD4001A	—
M6	280023	" " " "	"	"	—
M7	280023	" " " "	"	"	—
M8	280008	" " NAND "	"	MC4011CP	1
M9	290028	312 OP AMP SELECTED KIT	DATRON		1
M10	280022	QUAD BILATERAL SWITCH	RCA	CD4016A	—
M11	290014	312 OP AMP SELECTED	NATIONAL	LM312H (GREEN/ORANGE)	1
M12 *	290012	741 " " "	FAIRCHILD	741HC (RED/ORANGE)	2
M13 †	290023	741 " " "	"	" (RED/WHITE)	1
M14 *	290012	741 " " "	"	" (RED/ORANGE)	—
M15	260012	3130 " " "		CA3130	2
M16	260012	3130 " " FET I/P		"	—
M17	280025	QUAD BILATERAL SWITCH	RCA	CD4066A	1
M18	290019	301 OP. AMP. SELECTED	NATIONAL	LM301AH (RED/WHITE)	1
M19	290009	301 " " "	"	" (BLACK/WHITE)	1
M20	290025	RMS MODULE I.C. KIT	DATRON		1
M21	290010	301 OP. AMP. SELECTED	NATIONAL	LM301AH (RED/ORANGE)	2
M22	290010	301 " " "	"	" "	—

NOTES. * M12, M14 ALTERNATIVE 290010 TYPE LM301AH (RED/ORANGE)
† M13 " 290019 " " (RED/WHITE)

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SHEET 16 OF —

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
	090018				
ANI*	090006	ATTEN. NETWORK	ALLEN BRADLEY	FN333	1
SB1	700031	SWITCH BANK 4 X 2 POLE	INTERLOCK		1
SB2	700033	" " 8+8+6+8 POLE			1
SB3	700035	" " 2+2+2+0+0+2+2 POLE INTERLOCK			1
SB4	700036	" " 4+6+8+0+0+8+6 POLE			1
J3	605002	SOCKET 16 PIN D.I.L.	ANTIFERENCE	ICN-163-S3	1
	602001	FSV TERMINAL	MOLEX	02-04-1875	28
	601002	SNAP CONNECTOR	AMP	60803-1	8
	620003	SOLDER TERMINAL	HARWIN	H2105A	23
	612004	STANDOFF M3 x 4 LONG	"	CS2116/B	2
	612005	" M3 X 22 LONG	"	CS2116/C	2
	614001	" ϕ3.7 x 4 LONG	"	CS2117/B	6
	620001	P.T.F.E. CLOVERLEAF	SEALECTRO	FT-E-12	9†
	620002	P.T.F.E. STANDOFF		STSMIP15	11
	602006	D.I.L. BUCKET 7 WAY	MOLEX	2460-7	20
	602004	D.I.L. SOCKET STRIP	"	1938-4	156
	540002	B.T.C. WIRE 22 S.W.G.			A/R
	590004	SLEEVE			A/R
	630025	DOUBLE SIDED TAPE	BDK PACKAGING		A/R

NOTES. * ANI ALTERNATIVE 090016 MANN COMPS.
† 4 EXTRA REQUIRED WHEN ANI ALTERNATIVE IS USED.

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SHEET 17 OF —

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
	410024-5	P.C. BOARD			1
	700010	BUTTON BLACK	LIPA & ISOSTAT	4273	9
	630023	ADHESIVE CABLE CLIP	SCOTCHFLEX	706	1
	450004	ENVIRONMENTAL SHIELD	TIMPAK		1
	450067	A.C. INPUT SHIELD			1
	450064	UPPER GUARD SHIELD			1
	450063	LOWER " "			1
	611004	SCREW POSIPAN M3X6			6
	611006	" " M3X10			2
	613005	SHAKEPROOF M3			8

NOTES.

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SHEET 18 OF 18

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R21, R22	008008	4K7. ½W THICK FILM			2
C57, C58	130045	15pF 630v 5% "	SUFLEX	HS	2
	410025-6	P.C. BOARD		410025-6	1
	620003	TERMINAL RIVET	HARWIN	H210SA	12
	612008	STANDOFF M3 x 6mm LG.	CAMBION	350-5138-09-07	2

NOTES.

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12/1/76	12/2/76	26.2.76

DATE 1/12/75

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TITLE 1057 1059 -SWITCH BD. ASSY.

DRAWING NUMBER 400097

SHEET 2 OF 2

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R1	000102	1K 5% ¼W CARBON	MULLARD	CR25	8
R2	000272	2K7 " " "	"	"	3
R3	063203	20K POT CERMET	BECKMAN	72P	1
R4	000221	220R 5% ¼W CARBON	MULLARD	CR25	2
R5	000221	220R " " "	"	"	–
R6	090024	36K07 MATCHED PAIR	MANN	M250A	1
R7		9K1			
R8	000103	10K 5% ¼W CARBON	MULLARD	CR25	17
R9	000102	1K " " "	"	"	–
R10	000103	10K " " "	"	"	–
R11	000103	10K " " "	"	"	–
R12	000103	10K " " "	"	"	–
R13	000103	10K " " "	"	"	–
R14	000103	10K " " "	"	"	–
R15	000103	10K " " "	"	"	–
R16	000103	10K " " "	"	"	–
R17	000103	10K " " "	"	"	–
R18	011004	1M 1% ⅛W MF	WELWYN	4033C	1
R19	000185	1M8 10% ¼W CARBON	MULLARD	CR25	1
R20	000105	1M " " "	"	"	8
R21	000105	1M " " "	"	"	–
R22	000105	1M " " "	"	"	–
R23	000105	1M " " "	"	"	–

NOTES.

J. W. 1164

ISS.	A	B	C	D	E	F			
	–	–	288	246	301	304			
	24.5.76.	14-6-76	13-9-76	17.11.76	19-10-76	28-8-76			

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TITLE 1057 A-D

DRAWING NUMBER 400161

SHEET 2 OF 21

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R24	000153	15K 5% ¼W CARBON	MULLARD	CR25	1
R25	000102	1K " " "	"	"	–
R26	000104	100K " " "	"	"	8
R27		NOT USED			–
R28		"			–
R29	000104	100K 5% ¼W CARBON	MULLARD	CR25	–
R30	000104	100K " " "	"	"	–
R31	000103	10K " " "	"	"	–
R32	000106	10M 10% " "	"	"	3
R33	000395	3M9 " " "	"	"	1
R34	000106	10M " " "	"	"	–
R35	000106	10M " " "	"	"	–
R36	011002	10K 1% ⅛W MF	WELWYN	4033C	2
R37	011302	13K " " "	"	"	1
R38	000562	5K6 5% ¼W CARBON	MULLARD	CR25	3
R39		F.S.V. PART OF KIT 219005	WELWYN	4033C	–
R40	000822	8K2 5% ¼W CARBON	MULLARD	CR25	1
R41	000682	6K8 " " "	"	"	4
R42	000472	4K7 " " "	"	"	4
R43		F.S.V. 10% ¼W CARBON (2M7)	"	"	1
R44	000220	22R 5% ¼W CARBON	"	"	1
R45		NOT USED			–
R46	063101	100R POT CERMET	BECKMAN	72P	1

NOTES.

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SHEET 3 OF –

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R47	000222	2K2 5% ¼W CARBON	MULLARD	CR25	2
R48		NOT USED			-
R49		"			-
R50	000102	1K 5% ¼W CARBON	MULLARD	CR25	-
R51	000472	4K7 " " "	"	"	-
R52	000222	2K2 " " "	"	"	-
R53	000224	220K " " "	"	"	1
R54	000103	10K " " "	"	"	-
R55	000103	10K " " "	"	"	-
R56		NOT USED			-
R57	000472	4K7 5% ¼W CARBON	MULLARD	CR25	-
R58	000101	100R " " "	"	"	6
R59	000101	100R " " "	"	"	-
R60	000101	100R " " "	"	"	-
R61	000473	47K " " "	"	"	1
R62	000184	180K " " "	"	"	1
R63	011002	10K 1% ⅛W M.F	WELWYN	4033C	-
R64	013902	39K " " "	"	"	1
R65	017870	787R " " "	"	"	1
R66	090023	8K2 MATCHED PAIR	MANN	M250A	1
R67		6K65			
R68	090019	10K MATCHED PAIR	"	"	1
R69		10K			

NOTES.

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DRAWING NUMBER 400161

SHEET 4 OF ---

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R70		F.S.V. 1% 1/8W M.F.	WELWYN	4033C	1
R71		F.S.V. " " "	"	"	1
R72	000272	2K7 5% 1/4W CARBON	MULLARD	CR25	–
R73	000155	1M5 10% " "	"	"	1
R74	000682	6K8 5% " "	"	"	–
R75	000682	6K8 " " "	"	"	–
R76	063200	20R POT CERMET	BECKMAN	72P	2
R77		NOT USED			–
R78	063200	20R POT CERMET	BECKMAN	72P	–
R79		NOT USED			–
R80	063504	500K POT CERMET	BECKMAN	72P	2
R81	063504	500K " "	"	"	–
R82	063205	2M " "	"	"	1
R83	000563	56K 5% 1/4W CARBON	MULLARD	CR25	1
R84	000104	100K " " "	"	"	–
R85	000102	1K " " "	"	"	–
R86	000105	1M 10% " "	"	"	–
R87	000105	1M " " "	"	"	–
R88		NOT USED			–
R89		"			–
R90	000101	100R 5% 1/4W CARBON	MULLARD	CR25	–
R91	000101	100R " " "	"	"	–
R92	000101	100R " " "	"	"	–

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SHEET 5 OF

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R93	000182	1K8 5% 1/4W CARBON	MULLARD	CR25	2
R94		F.S.V. 10% " " (15M)	ALLEN BRADLEY	CB10	1
R95		NOT USED			–
R96		"			–
R97		NOT USED			–
R98		"			–
R99		"			–
R100		"			–
R101		"			–
R102		"			–
R103	000151	150R 5% 1/4W CARBON	MULLARD	CR25	1
R104	000562	SK6 " " "	"	"	–
R105	000562	SK6 " " "	"	"	–
R106	000331	330R " " "	"	"	1
R107	000390	39R " " "	"	"	1
R108	000105	1M 10% " "	"	"	–
R109	000102	1K 5% " "	"	"	–
R110	000103	10K " " "	"	"	–
R111	000102	1K " " "	"	"	–
R112	063102	1K POT CERMET	BECKMAN	72P	1
R113	019101	9K1 1% 1/8W M.F.	WELWYN	4033C	2
R114	019101	9K1 " " "	"	"	–
R115		NOT USED			–

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SHEET .. 6. OF

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R116		NOT USED			–
R117	000102	1K 5% ¼W CARBON	MULLARD	CR25	–
R118		NOT USED			–
R119		"			–
R120		"			–
R121		"			–
R122		"			–
R123		"			–
R124		"			–
R125		"			–
R126		"			–
R127		"			–
R128		"			–
R129		"			–
R130		"			–
R131		"			–
R132		"			–
R133		"			–
R134	000104	100K 5% ¼W CARBON	MULLARD	CR25	–
R135	000823	82K " " "	"	"	1
R136	000103	10K " " "	"	"	–
R137	000103	10K " " "	"	"	–
R138	000223	22K " " "	"	"	4

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SHEET 7 OF

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R139	000123	12K 5% ¼W CARBON	MULLARD	CR25	1
R140		NOT USED			—
R141	000223	22K 5% ¼W CARBON	MULLARD	CR25	—
R142	000223	22K " " "	"	"	—
R143	000104	100K " " "	"	"	—
R144	000104	100K " " "	"	"	—
R145	000333	33K " " "	"	"	2
R146	000393	39K " " "	"	"	1
R147	000333	33K " " "	"	"	—
R148	000104	100K " " "	"	"	—
R149	000182	1K8 " " "	"	"	—
R150	000103	10K " " "	"	"	—
R151	000683	68K " " "	"	"	1
R152	000472	4K7 " " "	"	"	—
R153	000682	6K8 " " "	"	"	—
R154	000332	3K3 " " "	"	"	1
R155	000223	22K " " "	"	"	—
R156	000272	2K7 " " "	"	"	—
R157		NOT USED			—
R158		"			—
R159		"			—
R160		"			—
R161		"			—

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SHEET 8 OF —

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R162		NOT USED			—
R163	000103	10K 5% ¼W CARBON	MULLARD	CR25	—
R164	000105	1M 10% " "	"	"	—
T1 - T3	310001	PULSE TX	NEWPORT INSTR.	76616/4	3
T4	300002	TOROIDAL MAINS TX	PLESSY WINDINGS		1
T5	300006	STEP-UP TX 5-0-5/90 POT CORE	NEWPORT INSTR.	B79399	1
L1	370001	R.F. CHOKE 10μH	PLESSY	58/10/0100/10	1
W1	209003	BRIDGE RECTIFIER 100V 1.5A	G.I.	WS01	1
W2, W3	209004	" " 100V 1A	G.I.	W01	2
W4	209007	" " 400V 1A	G.I.	W04	1

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
C1	180023	1000pF 25V AL. ELECT	WIMA/SEATRONICS	PRINTILYT 3/CSB	5
C2	180023	1000pF " " "	" "	" "	–
C3	150001	22pF 16V TANT.	UNION CARBIDE	K22E16	11
C4	150001	22pF " "	" "	"	–
C5	150001	22pF " "	" "	"	–
C6	150001	22pF " "	" "	"	–
C7	150001	22pF " "	" "	"	–
C8	150001	22pF " "	" "	"	–
C9	150001	22pF " "	" "	"	–
C10	101103	10nF 250V CER. DISC.	ERIE	801	9
C11	101103	10nF " " "	"	"	–
C12	101103	10nF " " "	"	"	–
C13	101103	10nF " " "	"	"	–
C14	101103	10nF " " "	"	"	–
C15	150008	.47pF 35V TANT.	UNION CARBIDE	KR47E35	1
C16	101103	10nF 250V CER. DISC.	ERIE	801	–
C17	110017	22nF 250V POLYESTER	MULLARD	C280AE/P22K	1
C18		NOT USED			–
C19	102102	1nF 500V CER. DISC.	ERIE	801	4
C20	102100	10pF " " "	"	"	3
C21	102330	33pF " " "	"	"	3
C22	102330	33pF " " "	"	"	–
C23	102330	33pF " " "	"	"	–

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SHEET 10. OF --

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
C24	102100	10pF 500V CER. DISC.	ERIE	801	–
C25	102102	1nF " " "	"	"	–
C26		NOT USED			–
C27	150001	22µF 16V TANT	UNION CARBIDE	K22E16	–
C28	110012	150pF 400V POLYESTER	WIMA	TROPYFOL F	3
C29	110002	.15µF 250V "	MULLARD	C280AE/P150K	1
C30	140002	.47µF 400V POLYPROP.	WIMA	MKP10	1
C31		NOT USED			–
C32	110008	.68µF 100V POLYESTER	WIMA	MKS	1
C33	102101	100pF 500V CER. DISC.	ERIE	801	3
C34	102101	100pF " " "	"	"	–
C35	102101	100pF " " "	"	"	–
C36		NOT USED			–
C37	150001	22µF 16V TANT.	UNION CARBIDE	K22E16	–
C38	102102	1nF 500V CER. DISC.	ERIE	801	–

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SHEET 11 OF —

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
C100	180023	1000pF 25V AL. ELECT.	WIMA/SEATRONICS	PRINTILYT 3/CSB	-
C101	180023	1000pF " " "	" "	" "	-
C102	101103	10nF 250V CER. DISC.	ERIE	801	-
C103	150003	47µF 6V3 TANT.	UNION CARBIDE	K47E6	1
C104	110015	15nF 100V POLYESTER	WIMA	FKS2	2
C105	110015	15nF " "	"	"	-
C106	150001	22µF 16V TANT.	UNION CARBIDE	K22E16	-
C107	180023	1000pF 25V AL. ELECT.	WIMA/SEATRONICS	PRINTILYT 3/CSB	-
C108	180019	10pF 250V " "	ERIE	21101-100	1
C109	110012	150pF 400V TROPYFOL F	WIMA	TROPYFOL F	-
C110	110012	150pF " "	"	"	-
C111		NOT USED			-
C112		"			-
C113	150001	22µF 16V TANT.	UNION CARBIDE	K22E16	-
C114		NOT USED			-
C115		"			-
C116		"			-
C117		"			-
C118		"			-
C119	101103	10nF 250V CER. DISC.	ERIE	801	-
C120		NOT USED			-
C121		"			-
C122	102221	220pF 500V CER. DISC.	ERIE	801	1

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SHEET 12 OF —

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
C123	110005	10nF 250V POLYESTER	MULLARD	C280AE/P10K	2
C124	101103	10nF " CER. DISC.	ERIE	801	–
C125	102102	1nF 500V " "	"	"	–
C126	102471	470pF " " "	"	"	1
C127	110005	10nF 250V POLYESTER	MULLARD	C280AE/P10K	–
C128	102100	10pF 500V CER. DISC.	ERIE	801	–
C129		NOT USED			–
C130	150005	2·2μF 16V TANT.	UNION CARBIDE	K2R2E16	1
C131		NOT USED			–
C132		"			–
C133	110013	·1μF 250V POLYESTER	MULLARD	C280AE/P100K	2
C134		NOT USED			–
C135	110013	·1μF 250V POLYESTER	MULLARD	C280AE/P100K	–
D1	200008	Si LOW LEAKAGE	FAIRCHILD	IN458A	9
D2	200008	Si " "	"	"	–
D3		NOT USED			–
D4	200008	Si LOW LEAKAGE	FAIRCHILD	IN458A	–

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SHEET 13 OF –

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
D5		NOT USED			-
D6	200008	Si LOW LEAKAGE	FAIRCHILD	IN458A	-
D7	200008	Si " "	"	"	-
D8	200008	Si " "	"	"	-
D9	200008	Si " "	"	"	-
D10	200008	Si " "	"	"	-
D11	200001	Si G.P.		IN4148	18
D12	200001	Si "		"	-
D13	200001	Si "		"	-
D14	200008	Si LOW LEAKAGE	FAIRCHILD	IN458A	-
D15		NOT USED			-
D16	200001	Si G.P.		IN4148	-
D17	200001	Si "		"	-
D18	200001	Si "		"	-
D19	200001	Si "		"	-
D20	210100	ZENER 10V 400mW	MULLARD	BZY88-C10	2
D21	210100	" " "	"	"	-
D22	210056	" 5V6 "	"	BZY88-C5V6	3
D23	210056	" " "	"	"	-
D24	210056	" " "	"	"	-
D25	210240	" 24V "	"	BZY88-C24	1
D26	219005	REF. DIODE +1% 1/8W, 50ppm, M.F.		PART OF KIT	1
D27	200001	Si G.P.		IN4148	-

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SHEET 14 OF

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
D28		NOT USED			-
D29		"			-
D30		"			-
D31	200001	Si G.P.		IN4148	-
D32	200001	Si G.P.		"	-
D33	210082	ZENER 8V2 400mW	MULLARD	BZY88-C8V2	1
D34		NOT USED			-
D35		"			-
D36		"			-
D37	200001	Si G.P.		IN4148	-
D38		NOT USED			-
D39		"			-
D40		"			-
D41		"			-
D42		"			-
D43		"			-
D44		"			-
D45	200001	Si G.P.		IN4148	-
D46	200001	Si "		"	-
D47	200001	Si "		"	-
D48	200001	Si "		"	-
D49	200001	Si "		"	-
D50	210150	ZENER 15V 400mW	MULLARD	BZY8-C15	1

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
D51		NOT USED			-
D52		"			-
D53	200001	Si G.P.		IN4148	-
D54	200001	Si "		"	-
M1	280008	DIG. I.C. QUAD. NAND	MOTOROLA	MC14011CP	9
M2	270024	7 SEG. DECODER/DRIVER	SPERRY	DD700	1
M3	280001	4 POLE 2WAY MULTIPLEXER	NATIONAL	MM74C157N	1
M4	290016	DIG. VOLTMETER LOGIC	FAIRCHILD	3814DC	1
M5	280009	DIG I.C. HEX BUFFER	MOTOROLA	MC14049CP	4
M6	280003	" " QUAD. LATCH	"	MC14042CP	1
M7	280012	DECADE COUNTER	NATIONAL	MM74C163N	1
M8	280007	DIG. I.C. TRIPLE NAND	MOTOROLA	MC14023CP	2
M9	280010	DECADE COUNTER	NATIONAL	MM74C160N	1
M10	280008	DIG. I.C. QUAD. NAND	MOTOROLA	MC14011CP	-
M11	280009	" " HEX. BUFFER	"	MC14049CP	-
M12	280008	" " QUAD NAND	"	MC14011CP	-
M13	280011	" " DUAL D FLIP-FLOP	"	MC14013CP	3

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SHEET 16 OF

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
M14	280008	DIG. IC. QUAD. NAND	MOTOROLA	MC14011CP	-
M15	280008	" " " "	"	"	-
M16	280011	" " DUAL D FLIP-FLOP	"	MC14013CP	-
M17	280009	" " HEX BUFFER	"	MC14049CP	-
M18	280007	" " TRIPLE NAND	"	MC14023CP	-
M19	290003	TIMER - ASTABLE	SIGNETICS	NE555V	2
M20	280006	DIG. IC. DUAL J.K. FLIP-FLOP	MOTOROLA	MC14027CP	3
M21	280006	" " " " "	"	"	-
M22	280008	" " QUAD. NAND	"	MC14011CP	-
M23	280008	" " " "	"	"	-
M24		NOT USED			-
M25		"			-
M26		"			-
M27	290003	TIMER - ASTABLE	SIGNETICS	NE555V	-
M28		NOT USED			-
M29		"			-
M30		"			-
M31		"			-
M32		"			-
M33		"			-
M34		"			-
M35	260013	LINEAR I.C. LF356	NATIONAL	LF356	1
M36	290009	" " 301 OP. AMP.	"	LM301AH (BLK./WHITE)	2

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SHEET 17 OF

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
M37	290010	LINEAR IC. 301 OP. AMP.	NATIONAL	LM301AH (RED/ORANGE)	1
M38	290020	" " " " "	"	LM301AH (BLK/ORANGE)	1
M39	290012	" " 741 " "	FAIRCHILD	741HC (RED/ORANGE)	1
M40	290019	" " 301 " "	NATIONAL	LM301AH (RED/WHITE)	1
M41	290009	" " " " "	"	LM301AH (BLK./WHITE)	-
M42	280008	DIG. I.C. QUAD NAND	MOTOROLA	MC14011CP	-
M43	280009	" " HEX. BUFFER	"	MC14049CP	-
M44	280006	" " DUAL JK FLIP-FLOP	"	MC14027CP	-
M45	280011	" " " D " "	"	MC14013CP	-
M46	280008	" " QUAD. NAND	"	MC14011CP	-
M47	260017	LINEAR I.C. 15V REGULATOR	"	MC78M15	2
M48	260017	" " " "	"	"	-
M49	290004	" " 312 OP. AMP.	NATIONAL	LM312H (RED)	1
M50	260005	" " 5V REGULATOR	MOTOROLA	MC7805	1
Q1	230019	P MOSFET ENHANCEMENT	G.I.	MEM 806	1
Q2	230002	N FET SWITCH G.P.	TELEDYNE	U1994E/K4416-18	3
Q3	230002	" " " "	"	" "	-
Q4	230002	" " " "	"	" "	-
Q5		NOT USED			-
Q6, Q7, Q8	239018	MATCHED SET OF 3 FET'S	DATRON SEL. TELEDYNE	U1899E $\Delta R_{ON} < 10\Omega$	1 SET
Q9	230003	N FET SWITCH G.P.	TELEDYNE	U1899E/K4093-18	1

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
Q10	230001	N FET SWITCH		E201	3
Q11	230001	" " "		"	-
Q12	230001	" " "		"	-
Q13		NOT USED			-
Q14	240001	Si NPN G.P.		BC184K	8
Q15	240001	Si " "		"	-
Q16	240001	Si " "		"	-
Q17	240001	Si " "		"	-
Q18	240001	Si " "		"	-
Q19		NOT USED			-
Q20		"			-
Q21	240007	Si NPN G.P.	FAIRCHILD	2N3646	6
Q22	240007	Si " "	"	"	-
Q23	240007	Si " "	"	"	-
Q24	250001	Si PNP "		BC214K	2
Q25	240001	Si NPN "		BC184K	-
Q40	240001	Si NPN G.P.		BC184K	-
Q41	240001	Si " "		"	-
Q42	240011	Si " MED. POWER	FAIRCHILD	BC338	1

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DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
Q43	240007	Si NPN G.P.	FAIRCHILD	2N3646	-
Q44	240007	Si " "	"	"	-
Q45	240007	Si " "	"	"	-
Q46		NOT USED			-
Q47		"			-
Q48		"			-
Q49		"			-
Q50		"			-
Q51		"			-
Q52		"			-
Q53	250001	Si PNP G.P.		BC214K	-
Q54		NOT USED			-
Q55		"			-
J3	605002	16 WAY D.I.L. SOCKET	ANTIFERENCE	ICN-163-53	1
	612005	STANDOFF M3 x 22 mm	HARWIN	CS2116/C	3
	614003	" Ø3·3 x 6 mm	"	CS2117/A	5
	620003	SOLDER TERMINAL	"	H2105A	11
	602001	F.S.V. TERMINAL	MOLEX	0204 1875	10
	601002	CONNECTOR TERMINAL	AMP	60803-1	7

NOTES.

ISS.								
SEE SHT. 2								

DATE 24.5.76

DRAWN BY M D

CHECK

NEXT DRAWING

datron ELECTRONICS LTD

TITLE 1057 A-D

DRAWING NUMBER 400161

SHEET 20 OF -

J. W. 1164

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
	410019-8	P.C. BOARD			1
	459138	HEAT DISSIPATOR			2
	459139	" "			1
	618001	TRANSISTOR MTG. KIT			1
	611004	SCREW POSIPAN M3X6			2
	611006	" " M3X10			7
	613005	M3 SHAKEPROOF			9
	615002	M3 NUT			5
	450039	UPPER GUARD SHIELD			1
	540002	22SWG TINNED Cu WIRE			A.R.
	590004	SLEEVE Si RUBBER			A.R.
	590001	SLEEVE	HELLERMAN	HIS X 15	13
	602005	8WAY D.I.L. BUCKET	MOLEX	2460-8	24
	602006	7WAY " "	"	2460-7	28
	602004	D.I.L. SOCKET STRIP	"	1938-4	388
	605012	24WAY D.I.L. SOCKET	JERMYN	A23-2023Y	1
	613011	6BA NYLON WASHER			4
	60A017	MAINS CONNECTOR	MOLEX	10-08-1031	1

NOTES.

ISS.								
SEE SHT. 2								

DATE 24.5.76
DRAWN BY MD
CHECK
NEXT DRAWING

datron ELECTRONICS LTD

TITLE 1057 A-D

DRAWING NUMBER 400161

SHEET 21 OF

J.W. 1164

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
R1-R6	000222	2k2 5% ¼W CARBON	MULLARD	CR25	6
R7-R11	000104	100K " " "	"	"	5
R12-R16	000153	15K " " "	"	"	5
R17, R18	000472	4K7 " " "	"	"	2
R19	000823	82K " " "	"	"	1
R20	000124	120K " " "	"	"	1
C1-C5	110013	0·1μF 250V POLYESTER	MULLARD	C280 AE/P100K	5
D1-D7	200001	DIODE Si G.P.		IN4148	7
D8-D12	200008	DIODE Si LOW LEAKAGE		IN458A	5
Q1-Q5	250009	Si PNP Hi VOLTAGE		2N5401	5
Q6-Q10	240009	Si NPN Hi VOLTAGE	MOTOROLA	MPSL01	5
Q11-Q13	250001	Si PNP G.P.		BC214K	3
M1	280009	DIG. IC. HEX. INVERTER	MOTOROLA	MC14049CP	1

NOTES.

ISS.	A	B							
	–	ECO 291							
	20-5-76	15-9-76							

DATE	20.5.76
DRAWN BY	M.J.D.
CHECK	
NEXT DRAWING	

datron ELECTRONICS LTD

TITLE ·3" SPERRY DISPLAY ASSY. 1057

DRAWING NUMBER 400162

SHEET 2 OF 3

J. W. 1164

DESIGNATOR	DATRON PART No.	DESCRIPTION	PRINCIPAL MANUFACTURER	MANUFACTURER'S PART No.	No. USED Per Assy.
LP2-LP5	920005	FILAMENT LAMP 5V 60mA	G.I.	V683	4
	450003	FUNCTION BLOCK	NORWICH PLASTICS		1
	420049	V, mV, KΩ, MΩ DISPLAY NEG.			1
	611014	SCREW No4 X 3/8" SELF TAP.			1
	602004	D.I.L SOCKET STRIP	MOLEX	1938-4	16
	602005	D.I.L 8 WAY BUCKET	MOLEX	2460-8	2
	604003	CONNECTOR STRIP 11 WAY	AMP	163740-9	3
SP333	800005	DISPLAY .3" 8.8.8.	SPERRY	SP333	1
SP334	800013	DISPLAY .3" ±1.8.8.	SPERRY	SP334	1
	800008	SOCKET	SPERRY	CS333	2
	410031-4	P.C. BOARD			1
	900001	CYANOCRYLATE ADHESIVE		IS12	A/R
	630030	CREPE PAPER TAPE .200"	BRADY	CSR200	20mm

NOTES.

SEE SHT. 2 FOR LATEST ISSUE

ISS.								

DATE 20.5.76	datron ELECTRONICS LTD
DRAWN BY M.J.D.	TITLE .3" SPERRY DISPLAY ASSY 1057
CHECK	
NEXT DRAWING	DRAWING NUMBER 400162 SHEET 3 OF 3

J. W. 1164

DRAWING No. 400158

FIRST USED ON 1057

THIRD ANGLE PROJECTION

DRAWN IN ACCORDANCE WITH BS 308

4 OFF WIRE LINKING CLOVERLEAF 540002 SLEEVE WITH 550004

9 OFF P.T.F.E. CLOVERLEAF 620001

AN1
FIT EITHER 090006 AB PN333
OR 090018 MANN COMPS., R180, R181, C8, C55, C59, & P.T.F.E. CLOVERLEAF (620001) AND LINK SHOWN DASHED.

PROCEDURE FOR MOUNTING SWITCH BANKS

1. CHECK 2 OFF M3 STANDOFFS 612004 HAVE BEEN FITTED
2.
3. REMOVE SPRINGS FROM END OF LATCH BARS OF SB2 & SB4
4. ADD FORM STRIP (630025) 2 LAYERS 1/4" x 1/16" THICK TO UNDERSIDE OF EACH SWITCH FRAME.
5. TACK SWITCH BANKS IN POSITION ENSURING THAT THEY ARE DIRECTLY IN LINE WITH EACH OTHER AND PARALLEL TO SURFACE OF BOARD.
6. CHECK FOR SMOOTH OPERATION
7. SOLDER IN PLACE AND CLIP PINS ON ANALOGUE SIDE OF SWITCHES
8. SWITCH SPINDLE C/L TO BE 6.90 mm ABOVE TOP SURFACE OF P.C.B.
9. REMOVE SPRINGS FROM SPINDLE ENDS OF SB1 & SB3.

Q18 FIT 3mm ABOVE P.C.B.

J3 FIT TO OTHER SIDE

2 OFF M3 x 4 STANDOFF 612004 FIT TO OTHER SIDE

3 OFF WIRE LINK 540002 FIT BETWEEN SB2, SB4 FRAMES & GUARD TRACK

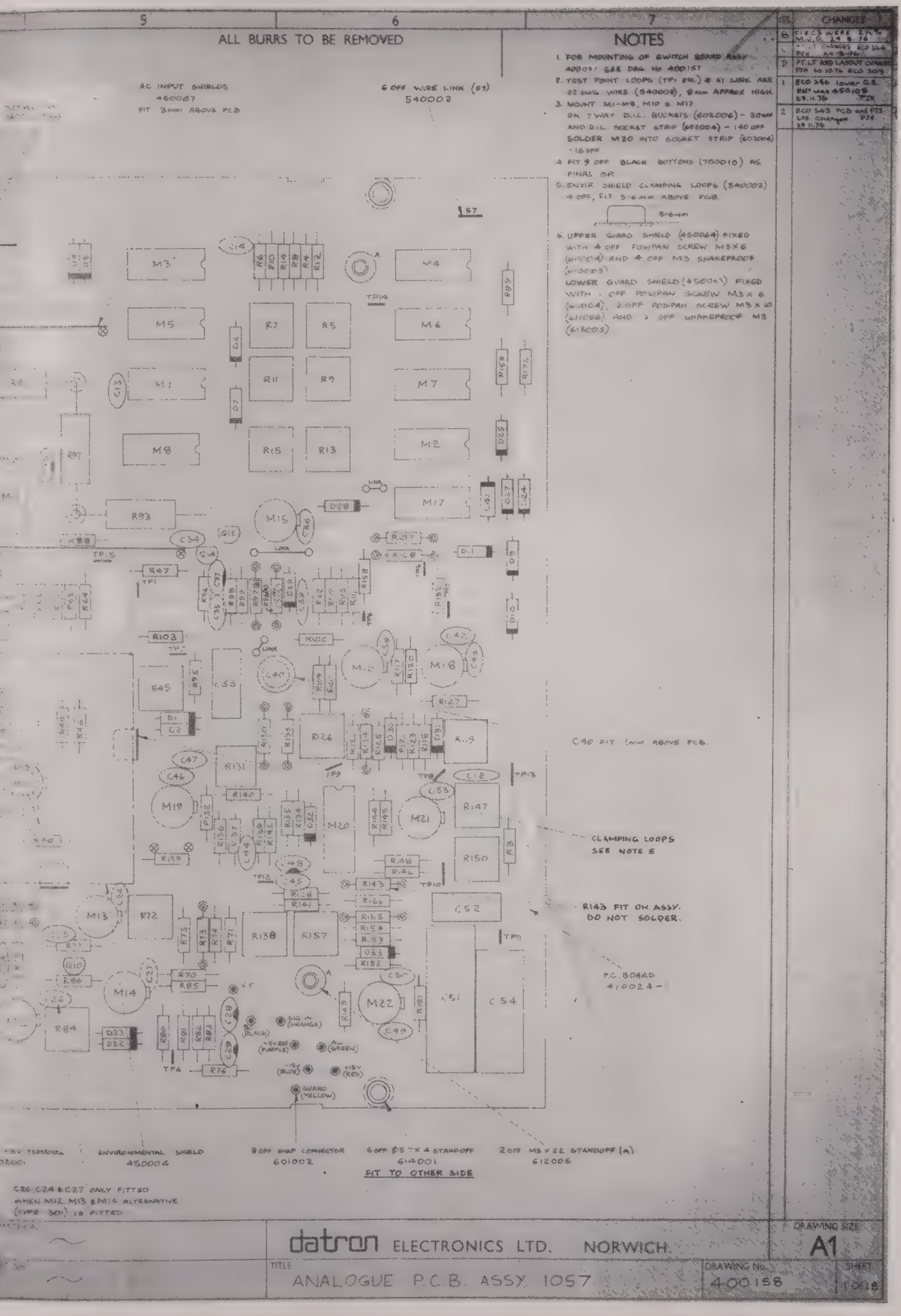
11 OFF P.C.B. STANDOFF 620002

4 OFF LINK (22 SWG) 540002 FIT DURING CAL./TEST

23 OFF SOLDER TERM. 620008

CABLE CL 630022

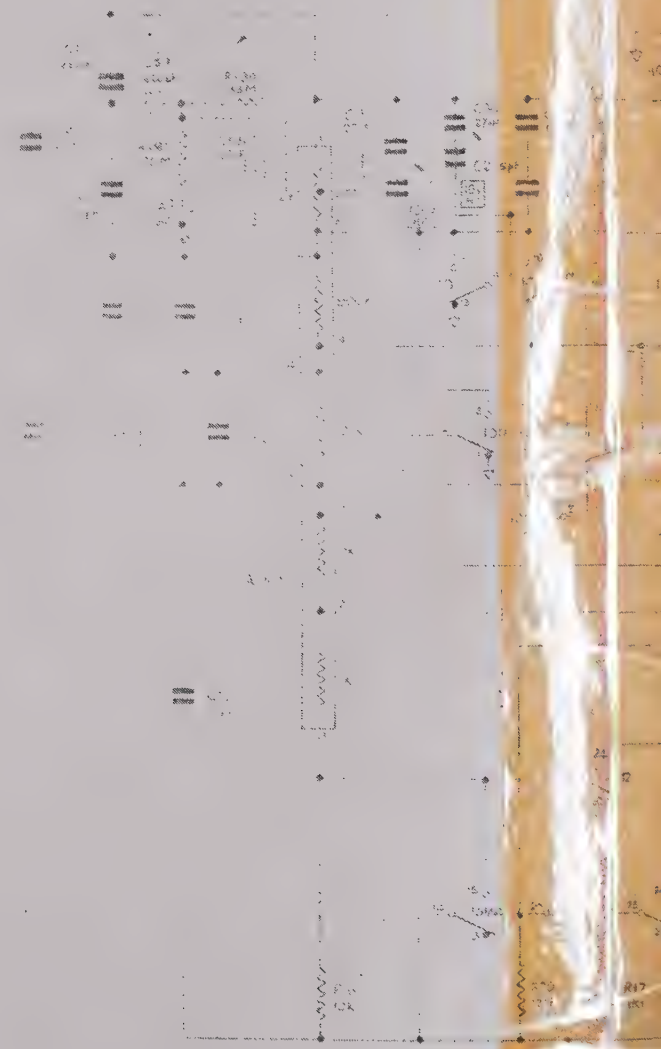
DRAWN	CHECKED	DIMENSIONS IN	TOLERANCES
M.J.D.		MILLIMETRES	LINEAR ANGULAR
TRACED	APPROVED		INCH DIMENSIONS
			DECIMAL TO 2 PLACES ±
DATE	DATE	SCALE	DECIMAL TO 3 PLACES ±
26.76		2:1	FRACTIONAL
		NOT TO BE SCALED	METRIC DIMENSIONS
			DECIMAL TO 2 PLACES ±
			DECIMAL TO 1 PLACE ±
			WHERE NO TOLERANCE IS GIVEN
			UNLESS OTHERWISE STATED

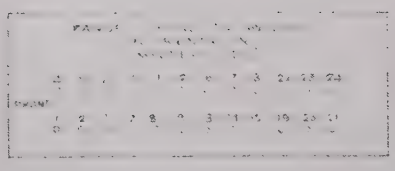

5
6
7
ALL BURRS TO BE REMOVED
AC INPUT SHIELDS
450067
FIT 3mm ABOVE PCB
6 OFF WIRE LINK (ST)
540002
NOTES
1. FOR MOUNTING OF SWITCH BOARD ASSY 400097 SEE DRG. No 400157
2. TEST POINT LOOPS (TP) ETC.) & K1 LINK ARE 22 SWG WIRE (540008), 8mm APPROX HIGH.
3. MOUNT M1-M9, M12 & M17 ON TWAY D.I.L. BUSSES (602006) - 30mm AND D.I.L. SOCKET STRIP (602004) - 140 OFF SOLDER M20 INTO SOCKET STRIP (602004) - 16 OFF
4. FIT 9 OFF BLACK BUTTONS (700010) AS FINAL OP.
5. ENVIR SHIELD CLAMPING LOOPS (540002) 4 OFF, FIT 5-6mm ABOVE PCB.
6. UPPER GUARD SHIELD (450064) FIXED WITH 4 OFF POZIPAN SCREW M3 X 6 (610004) AND 4 OFF M3 SHAKEPROOF (613003)
LOWER GUARD SHIELD (450065) FIXED WITH 1 OFF POZIPAN SCREW M3 X 6 (610004), 2 OFF POZIPAN SCREW M3 X 10 (610006) AND 3 OFF SHAKEPROOF M3 (613003)
C90 FIT 1mm ABOVE PCB.
CLAMPING LOOPS SEE NOTE 5
R143 FIT ON ASSY. DO NOT SOLDER.
P.C. BOARD 400248
ENVIRONMENTAL SHIELD 450004
9 OFF SNAP CONNECTOR 601002
6 OFF Ø3 TX 4 STANDOFF 614001
2 OFF M3 X 22 STANDOFF (A) 612006
FIT TO OTHER SIDE
C26, C24 & C27 ONLY FITTED WHEN M12, M13 & M14 ALTERNATIVE (TYPE 301) IS FITTED
ISS.
CHANGES
C123 WERE 2.7K
M.O. 29.8.76
CHANGES ECO 344
PCB 24.8.76
PT.S.T AND LAYOUT CHANGE ITEM 10.10.76 ECO 309
ECO 346 lower G.S. Ref was 450109 29.11.76 TPDK
ECO 343 PCB and PTS. L19 Changed. PTH 29.11.76
datron ELECTRONICS LTD. NORWICH.
DRAWING SIZE A1
TITLE
ANALOGUE P.C.B. ASSY. 1057
DRAWING No. 400158
SHEET 1 OF 18

430157

THIRD ANGLE PROJECTION

DRAWN IN ACCORDANCE WITH BS 308





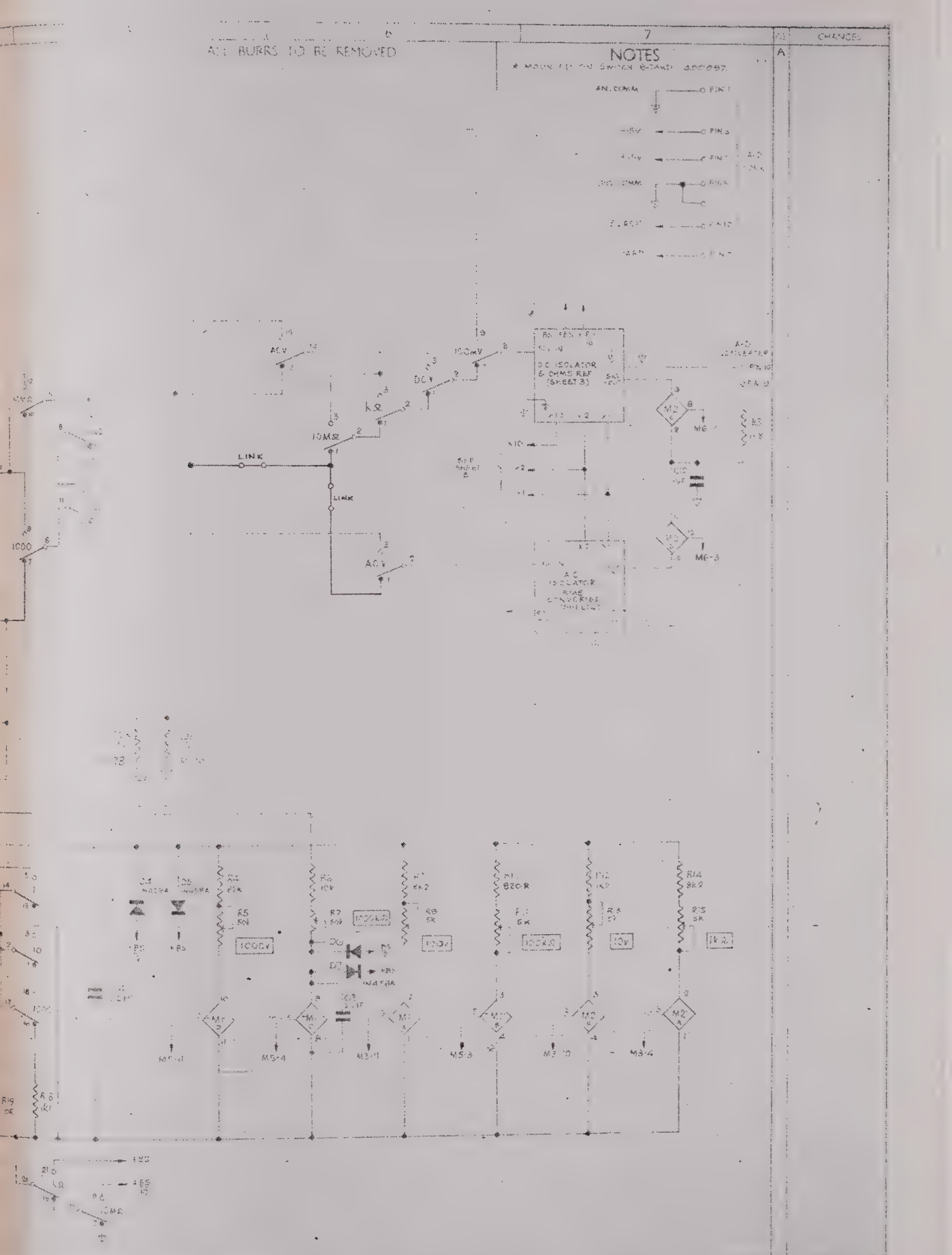
M.J.D.

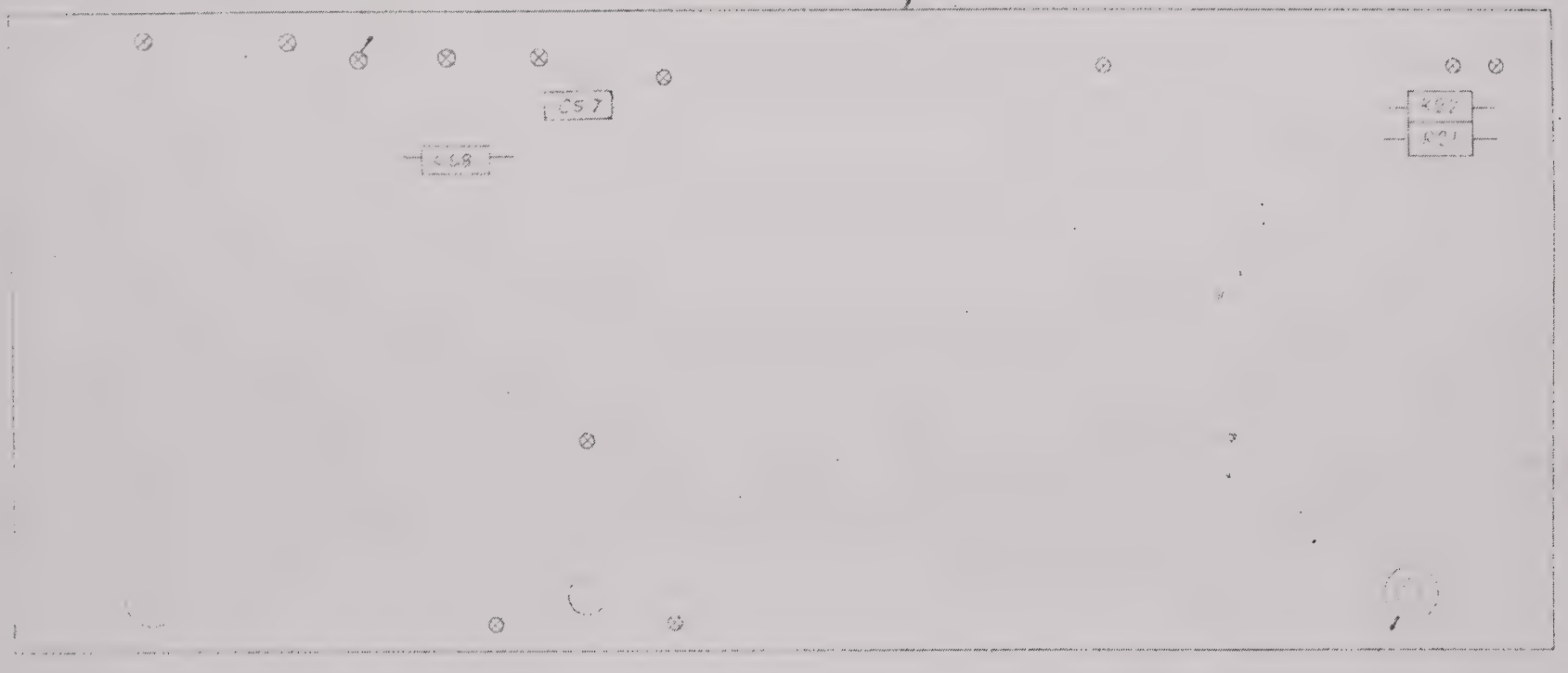
7.6.76

ALL BURRS TO BE REMOVED

NOTES

* MOUNTED ON SWITCH BOARD 300087.





2OFF M3 STANDOFF
@2.00"

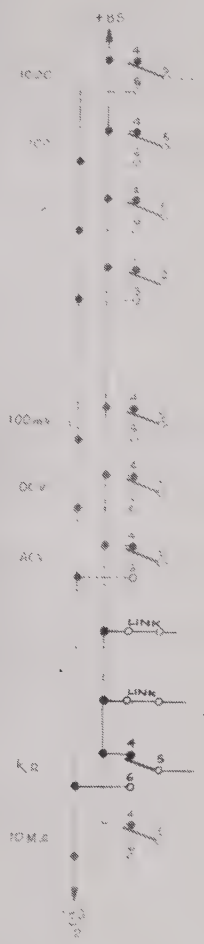
DIMENSIONS IN MILLIMETRES	TOLERANCES ANGULAR ± ½ NON DIMENSIONS DECIMAL TO 3 PLACES ± .05 DECIMAL TO 2 PLACES ± .08 FRACTIONAL ± 1/64 METRIC DIMENSIONS	MATERIAL /	datron ELECTRONICS LTD. NORWICH.
		FINISH	TITLE

DRAWING No. 430157

FIRST USED ON 1057

THIRD ANGLE PROJECTION

DRAWN IN ACCORDANCE WITH BS 308



NOTE: SWITCH CONTACTS FOR AN 8PT SELECTED SWITCH SHOWN 2 AND 4

DRAWN M.J.D.	CHECKED	DIMENSIONS IN MILLIMETRES	TOLERANCE: ANGULAR
TRACED	APPROVED	SCALE 1/1 NOT TO BE SCALED	ALL DIMENSIONS DECIMAL TO 1 PLACE ± 0.1 mm DECIMAL TO 2 PLACE ± 0.05 mm FRACTIONAL ± 1/64" METRIC DIMENSIONS DECIMAL TO 1 PLACE ± 0.1 mm DECIMAL TO 2 PLACE ± 0.05 mm WHOLE DIMENSIONS ± 0.5 mm UNLESS OTHERWISE STATED.
DATE 7.6.76	DATE		

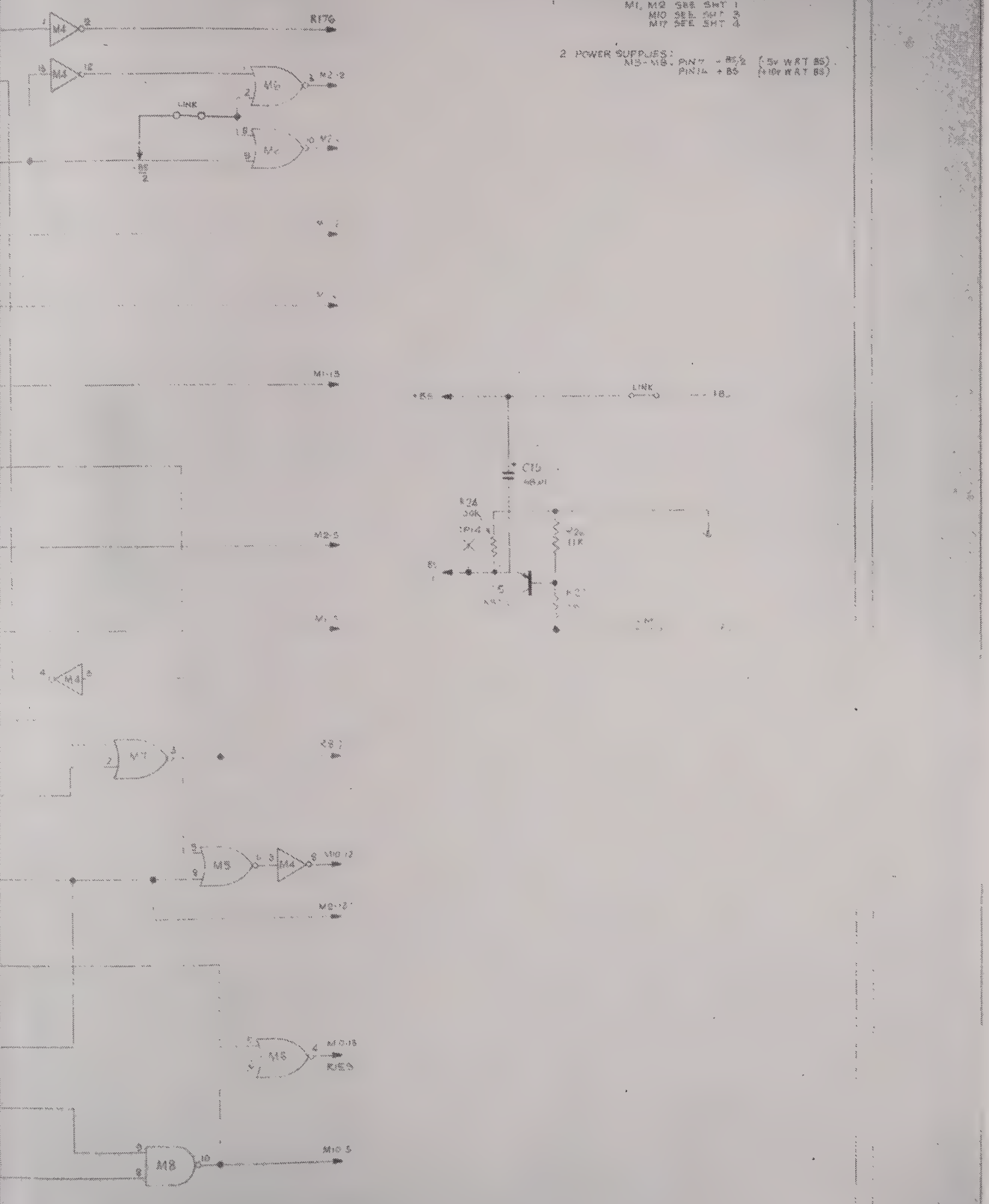
ALL BURRS TO BE REMOVED

NOTES

1 FOR QUAD BILATERAL SWITCHES:
M1, M2 SEE SHT 1
M10 SEE SHT 3
M17 SEE SHT 4

2 POWER SUPPLIES:
M3-M8. PIN 7 = 85½ (-5v WRT 85)
PIN 14 = 85 (+10v WRT 85)

CHANGE	
B	ECO 305 LINK was R25 REMOVE C16, D13, D14, R7, Q4, R23A, R29 PJM. 21.10.76



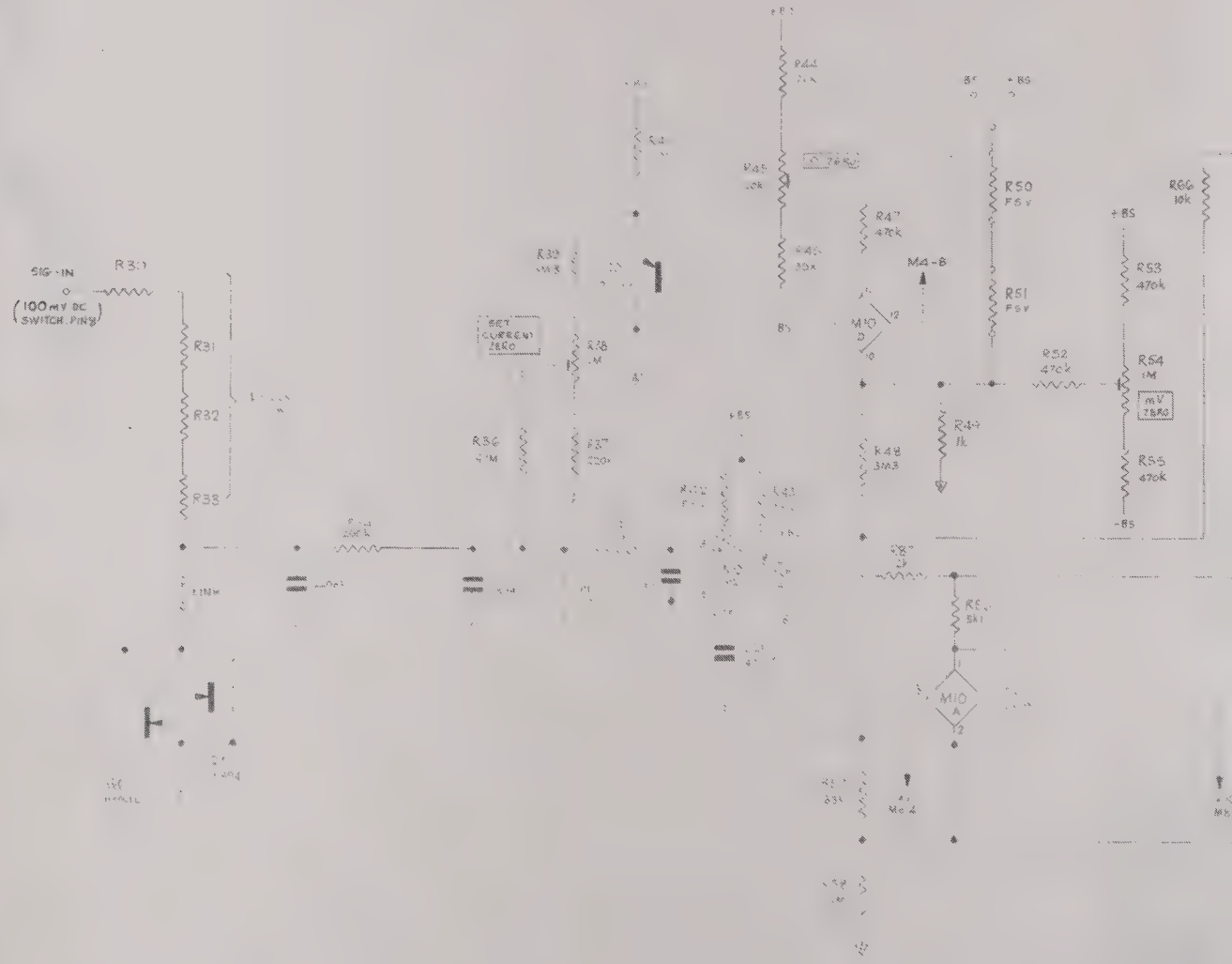
MATERIAL	datron ELECTRONICS LTD. NORWICH		DRAWING SIZE A1
FINISH	TITLE 1057 ANALOGUE RANGE CODING	430157	2 5

DRAWING No. 430157

FIRST USED ON 1057

THIRD ANGLE PROJECTION

DRAWN IN ACCORDANCE WITH BS 308



M J.D.

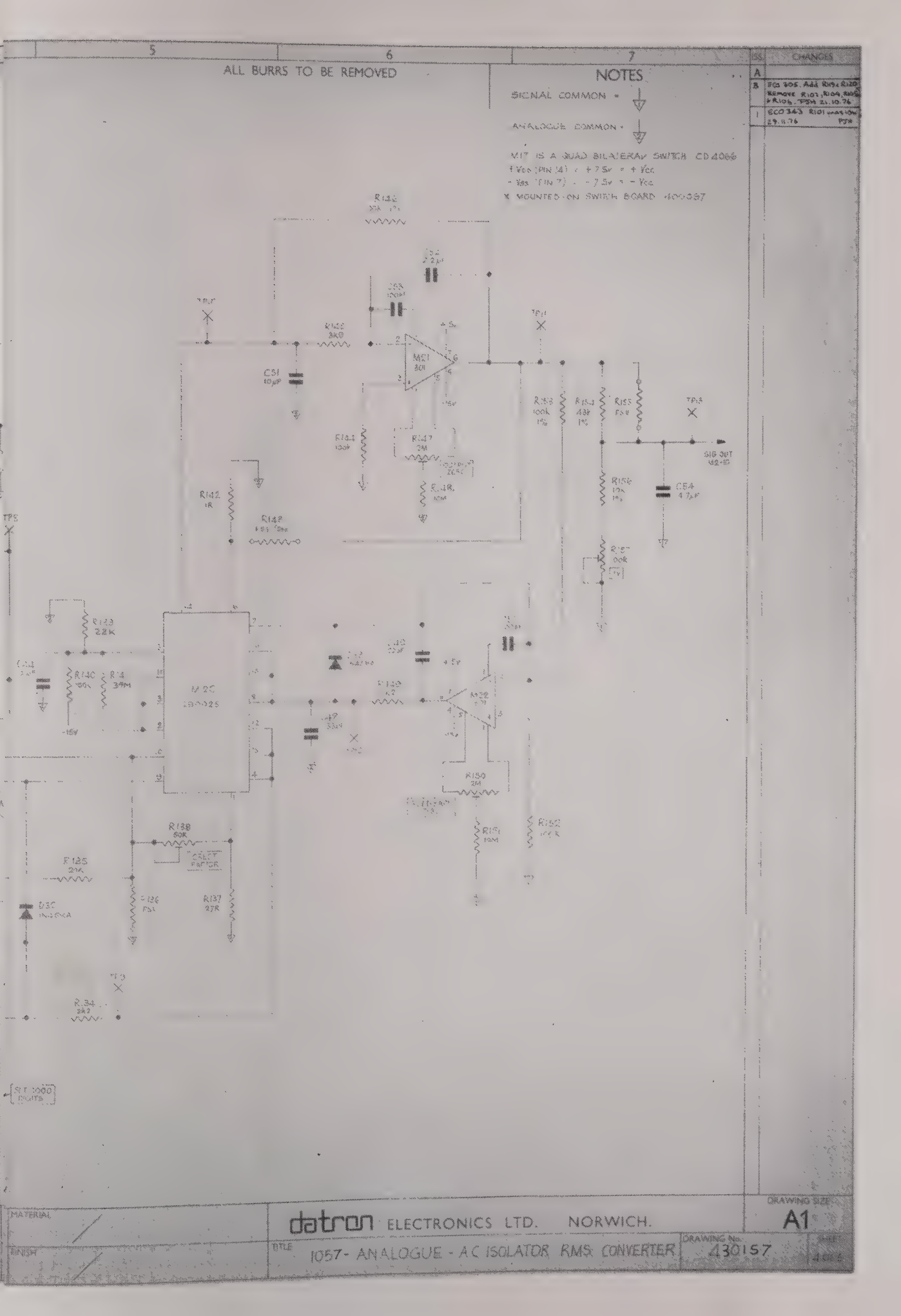
7 6 76

DIMENSIONS IN

MILLIMETRES

SCALE

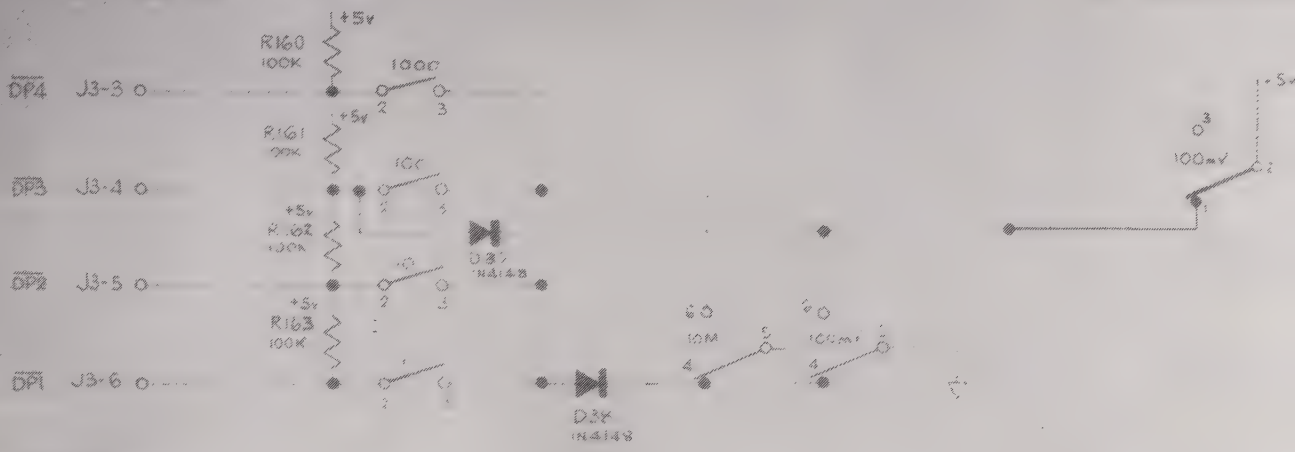
NOT TO BE SCALED

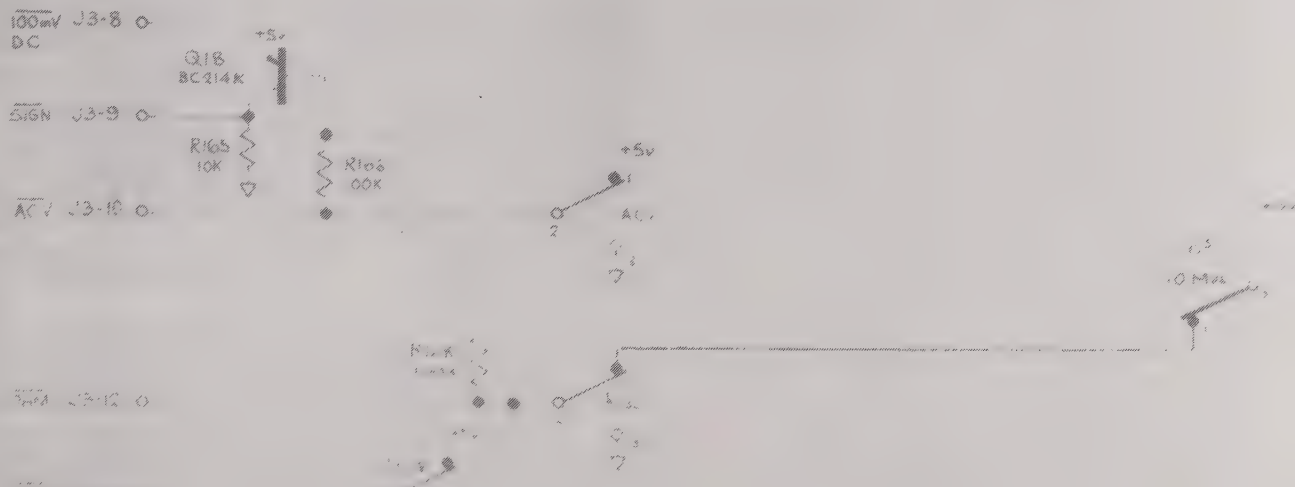

ALL BURRS TO BE REMOVED
NOTES
SIGNAL COMMON =
ANALOGUE COMMON =
MIT IS A QUAD BILATERAL SWITCH CD4066
+Vss (PIN 14) = +7.5V = +Vcc
-Vss (PIN 7) = -7.5V = -Vcc
X MOUNTED ON SWITCH BOARD 400087
CHANGES
A
B FCS 505. Add R154, R120. Remove R107, R109, R105 & R106. PSH 21.10.76
1 ECO 343 R101 was 10M 29.11.76 PSH
R138 50K
R135 22K
R136 FOR
R137 27R
D30 IN4148
R134 2K7
SEE 3000 DIGITS
MATERIAL
FINISH
datron ELECTRONICS LTD. NORWICH.
TITLE
1057 - ANALOGUE - AC ISOLATOR RMS CONVERTER
DRAWING No. 430157
DRAWING SIZE A1
SHEET 1 OF 2

DRAWING No.
430157
FIRST USED ON
1057

THIRD ANGLE PROJECTION

DRAWN IN ACCORDANCE WITH BS 308





M.J.D.

7.6.76.

4 | 5 | 6

ALL BURRS TO BE REMOVED

NOTES

ISS	CHANGES
A	

J3	FUNCTION
PIN 1	NOT USED
2	NOT USED
3	$\overline{D.P.4}$
4	$\overline{D.P.3}$
5	$\overline{D.P.2}$
6	$\overline{D.P.1}$
7	NOT USED
8	$\overline{100mV\ D.C}$
9	$\overline{SIGN}$
10	$\overline{A.C.V}$
11	NOT USED
12	$\overline{\Omega}$
13	$\overline{D.C.V}$
14	NOT USED
15	+5V
16	0v

ALL [illegible] SHOWN ARE IN [illegible] RACKS 2 AND 3

datron ELECTRONICS LTD. NORWICH.

DRAWING SIZE A2

1057 A-D COMMAND & FUNCTION INDICATION CCT

DRAWING No. 430157

SHEET 5 OF 5

IMPORTANT:

WHEN FITTING T4 TO BOARD, ALL FLYING LEADS SHOULD BE CUT TO SUFFICIENT LENGTH ALLOW FOR ½" LOOP TO FORM TO ALLOW TRANSFORMER RADIAL FREEDOM DURING CALIBRATION PROCEDURE

13 OFF SLEEVE 59 1001 (POS'NS MARKED THUS #)

1 OFF TRANSISTOR MOUNTING KIT 618001

2 OFF SCREW (M3 x 6)
2 OFF NUT (M3) 6:50
2 OFF SHAKEPROOF (M3

THE FOLLOWING ITEMS ARE USED TO SECURE T4, M47, M48 & M50:
4 OFF SCREW (M3 x 10mm LG) 611006
3 OFF NUT 615002 (NOT T4)
4 OFF M3 SHAKEPROOF 613005

MAINS CONNECTOR 604017

11 OFF SLEEVING 59 1001

1 OFF TRANSISTOR HEAT DISSIPATOR (M47, M48) 459 38

10 OFF PCB TERMINAL 604001

7 OFF CONNECTOR TERMINAL 601002

7 OFF SLEEVED LINK (540002 590004)

PIN No.	FUNCTION	WIRE COLOUR
	SIGNAL COMMON	SCREEN
	NOT USED	
	+15V	BLUE
	NOT USED	
	-15V	RED
	NOT USED	
	GUARD	YELLOW
	+5V COMMON	GREEN
	+5V INPUT	ORANGE
	+5V REF	BROWN
	NOT USED	

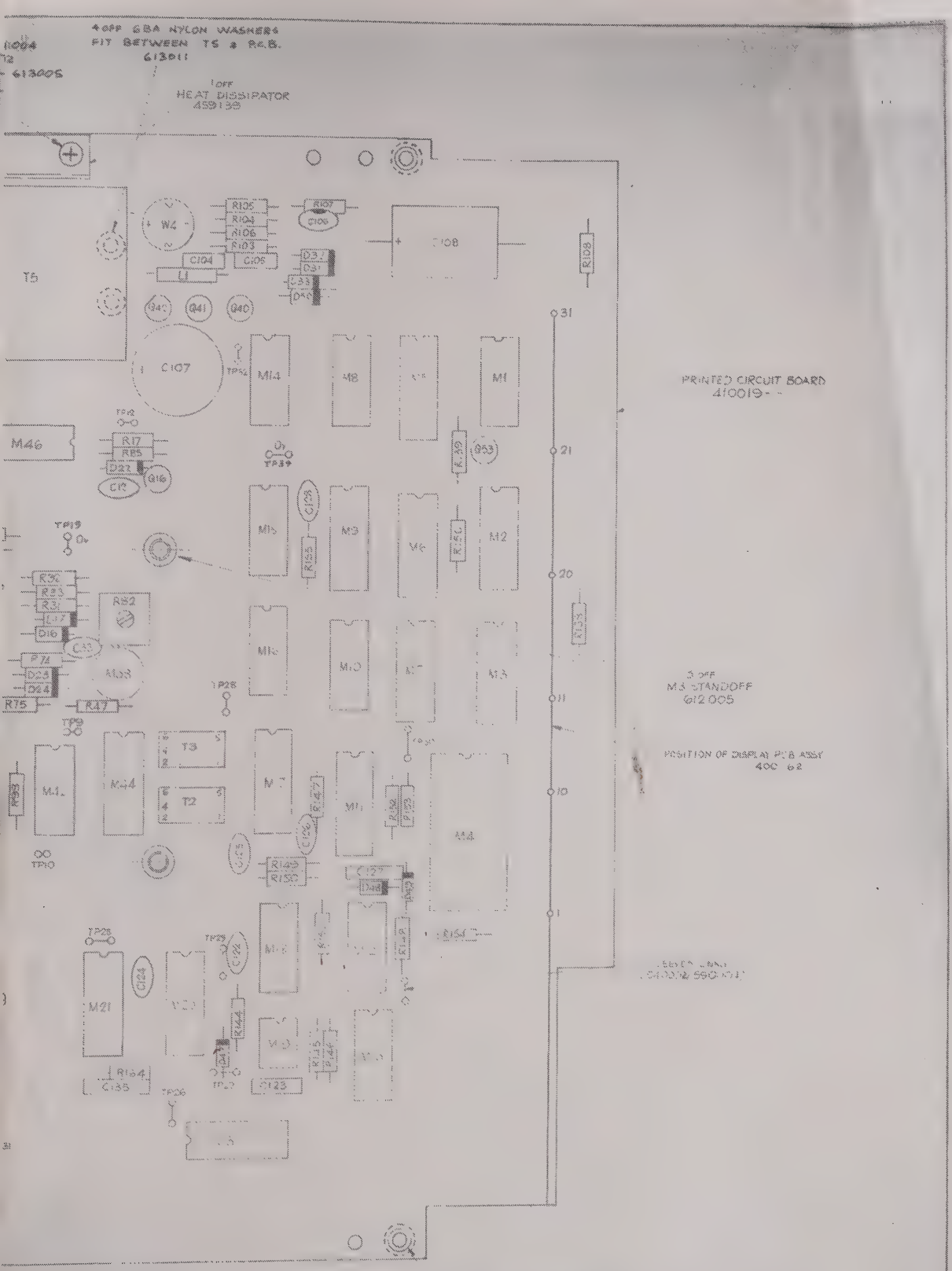
OTHER ITEMS REQD TO ASSEMBLE PCB:

1. 8 WAY D.I.L. BUCKET 602005 24 OFF
2. 7-WAY D.I.L. BUCKET 602006 28 OFF
3. [illegible] SOCKET 605 [illegible] 1 OFF
4. [illegible] SOCKET STRIP TERM'N 388 OFF 60

5. [illegible] LOOPS TO BE MADE FROM [illegible] WIRE [illegible] 2 OFF AS R
6. UPPER GUARD SHIELD 450039 SEE WITH SCREW M3 x 10 (611006) 3 AND SHAKEPROOF M3 (613005) 4

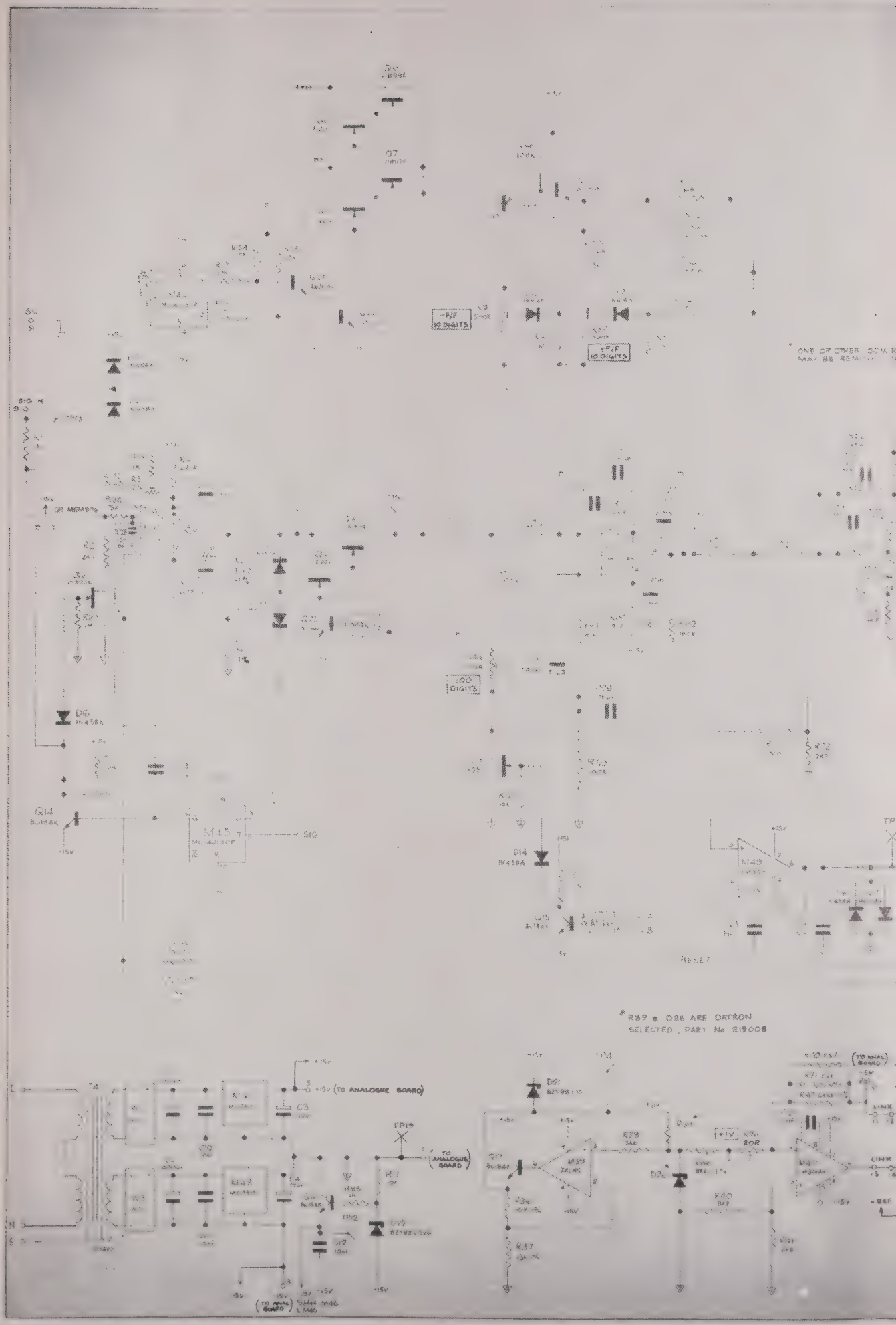
4 OFF 6BA NYLON WASHERS
FIT BETWEEN T5 & P.C.B.
613011

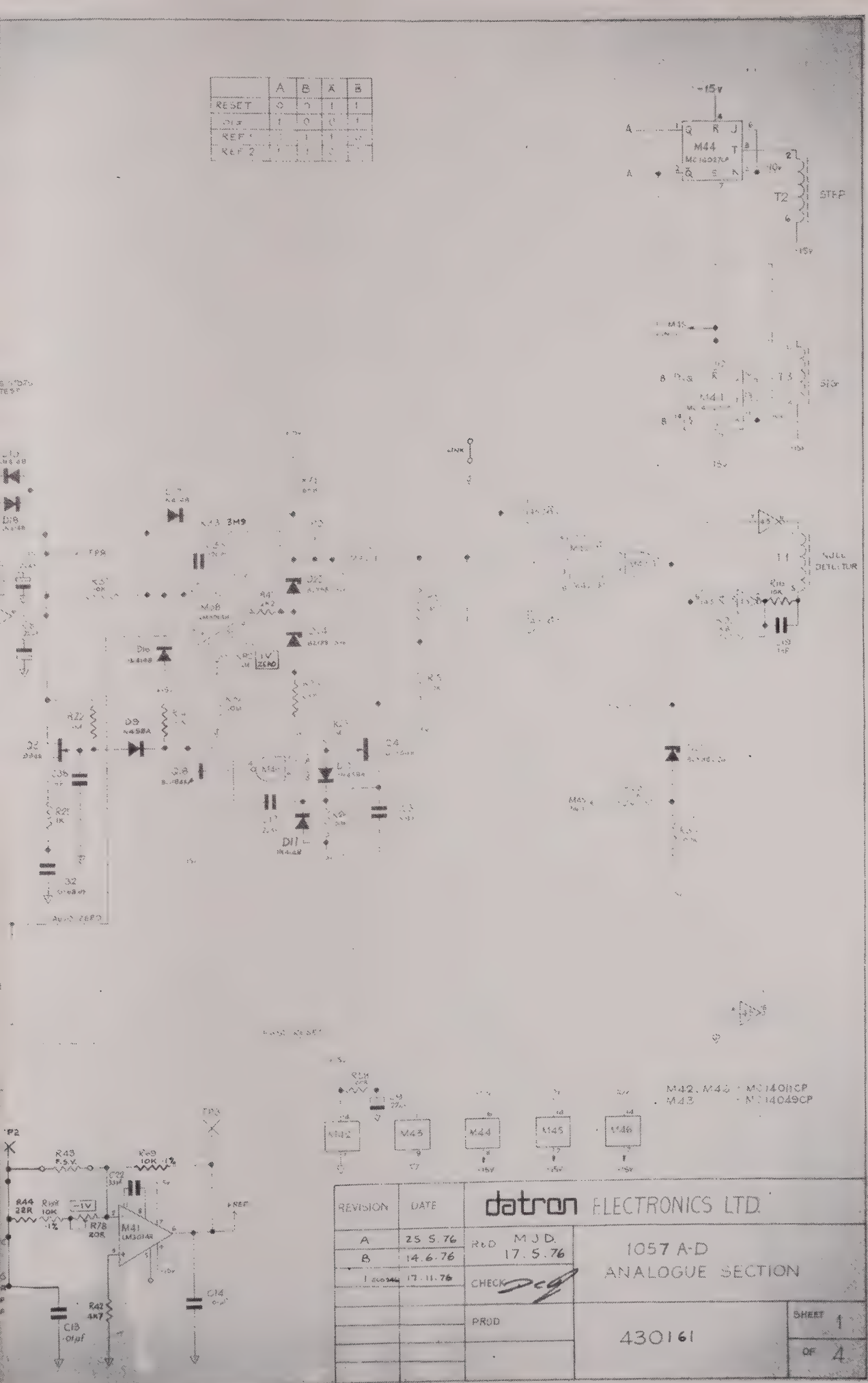
1 OFF
HEAT DISSIPATOR
4591138

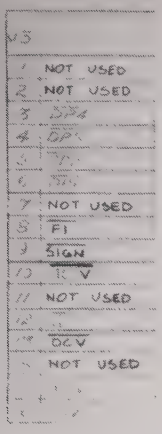


5 OFF M3 CLEAR X 6 LONG
STANDOFF 614003
FIT TO OTHER SIDE OF BOARD

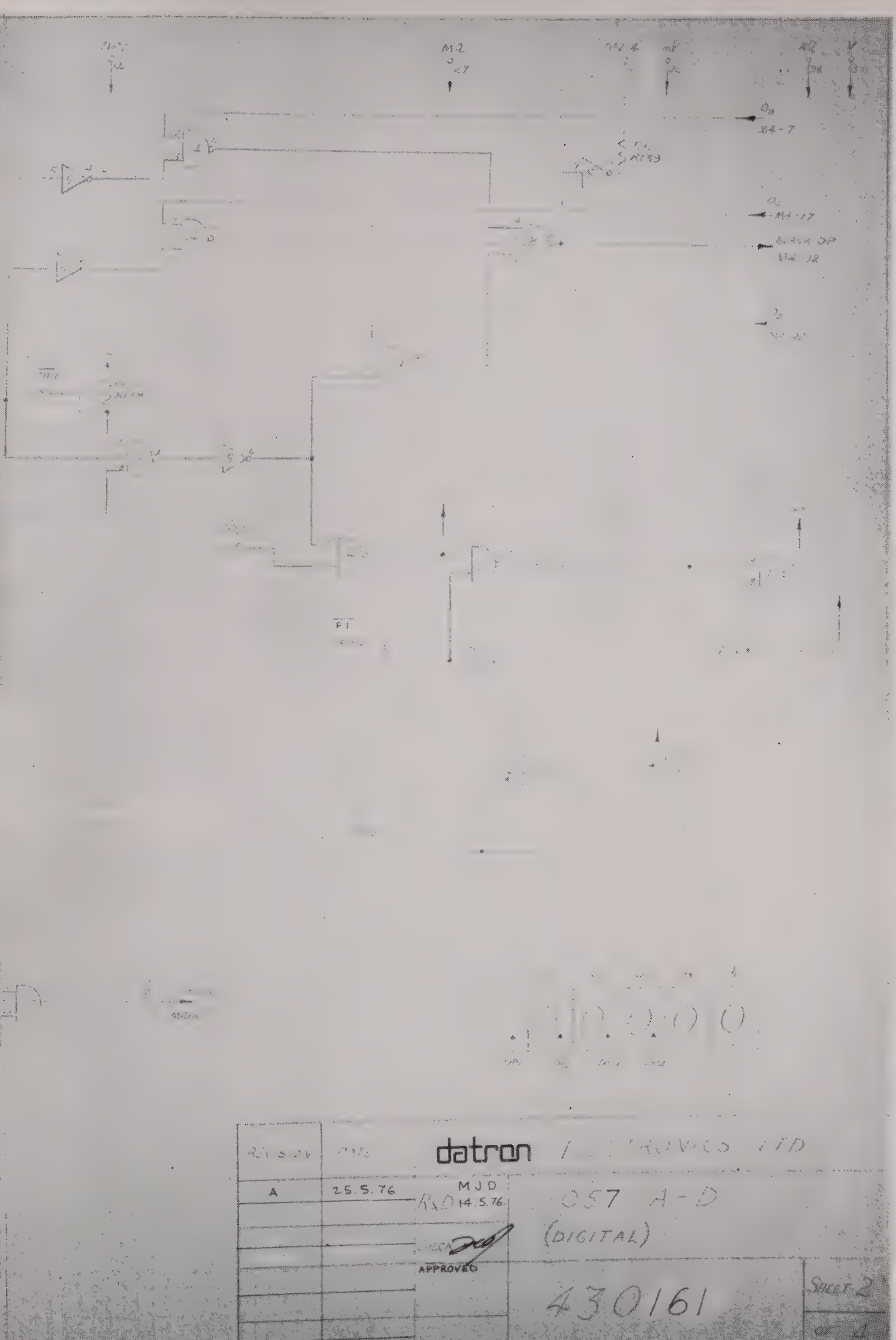
REVISION	DATE	datron ELECTRONICS LTD		
A	25 5 76	R+D M.J.D. 17.5.76	1057 A-D P.C.B ASSEMBLY	
B	14 6 76			
C - ECO 288	13 9 76	CHECK		
D - ECO 246	17 11 76			
E - ECO 301	19 10 76	PROD	400161	SHEET 1 OF 21
F - ECO 304	28 8 76			


-F/F 10 DIGITS
+F/F 10 DIGITS
100 DIGITS
D6 IN458A
D14 IN458A
Q14 BC184L
M43 MC14013CP
SIG
RESET
R39 & D26 ARE DATRON SELECTED, PART No 219005
TO ANALOGUE BOARD
D21 BZY88C10
M39 74LN0
M42 MC7815
M44 MC7915
M45
LINK
+15V
-15V
+5V
-5V


RESET
REF 1
REF 2
-15V
M44
T2
STEP
M41
M42
M43
M44
M45
M46
M42, M45 - MC14011CP
M43 - MC14049CP
R43 5.5K
R69 10K 1%
C22 33pf
R44 22R
R78 20K
M41 LM301AH
C18 01μf
R42 4K7
C14
REVISION
DATE
A 25.5.76
B 14.6.76
17.11.76
DRD M.J.D. 17.5.76
CHECK
PROD
datron ELECTRONICS LTD.
1057 A-D
ANALOGUE SECTION
430161
SHEET 1
OF 4


J5
1 NOT USED
2 NOT USED
3 SIG4
4 DP
5 5V
6 5V
7 NOT USED
8 F1
9 SIGN
10 -12V
11 NOT USED
12
13 GEV
14 NOT USED

M28/1
LINK
M28/9

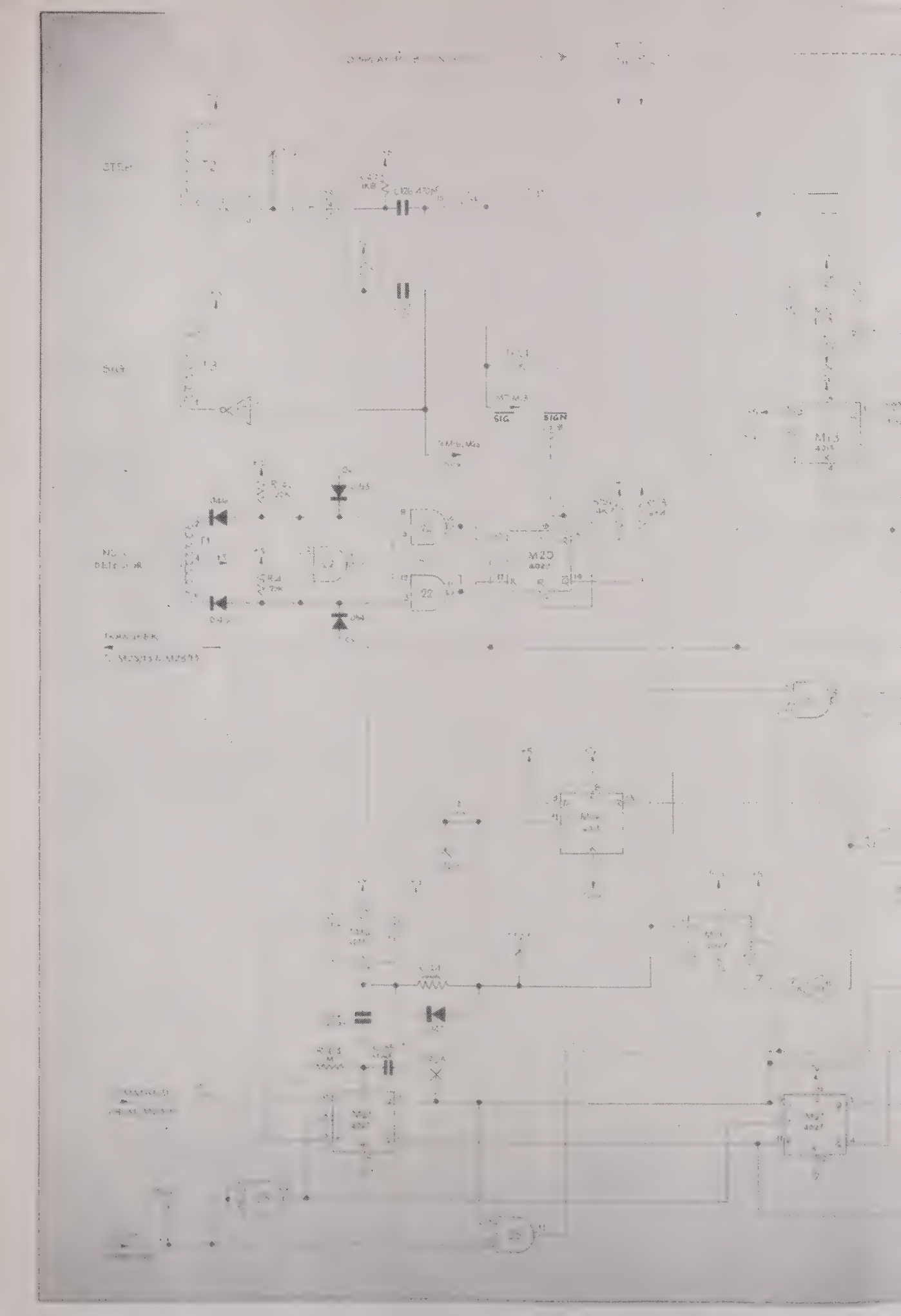


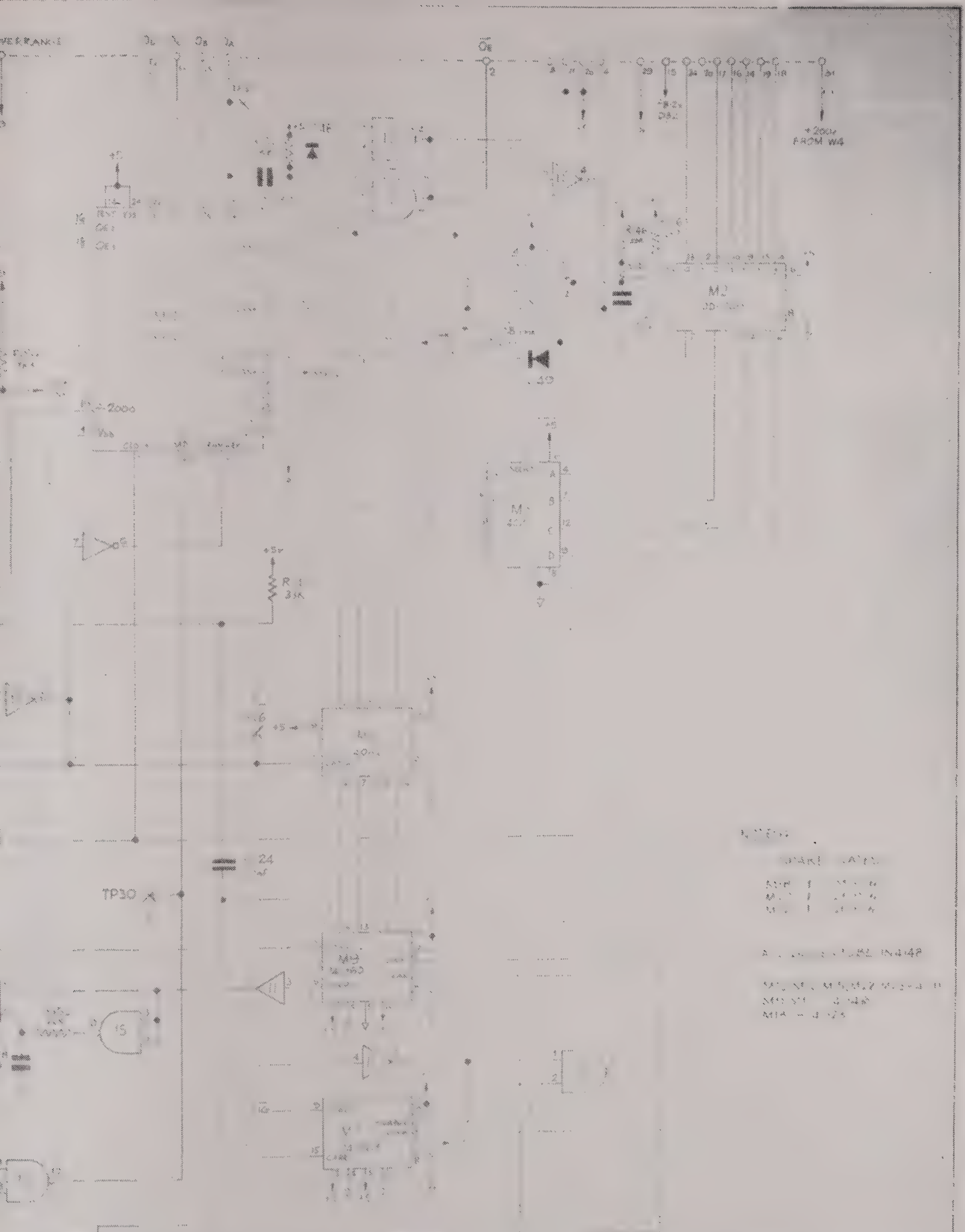
REVISN	DATE	datron
A	25.5.76	MJD 14.5.76
		APPROVED

057 A-D
(DIGITAL)

430161

SHEET 2 OF 4


SIG
SIGN
22

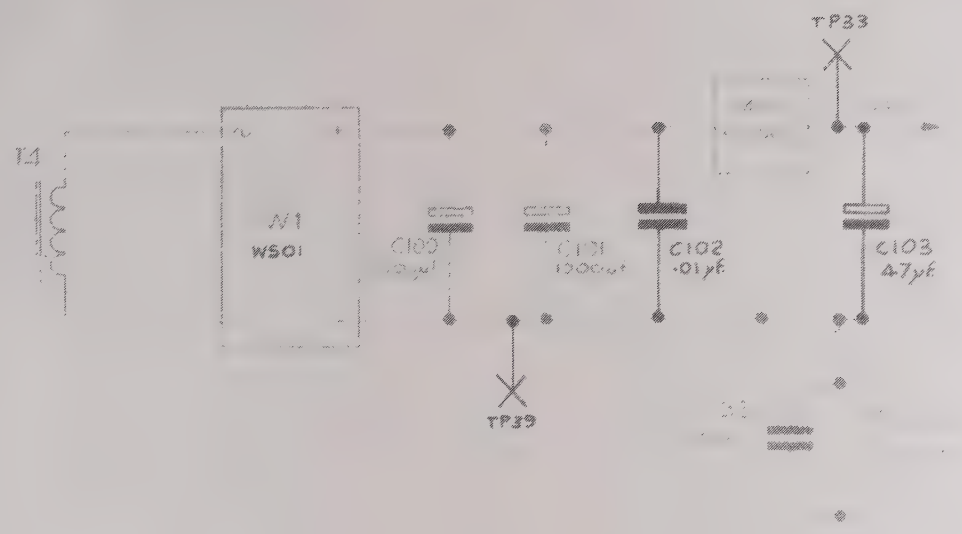


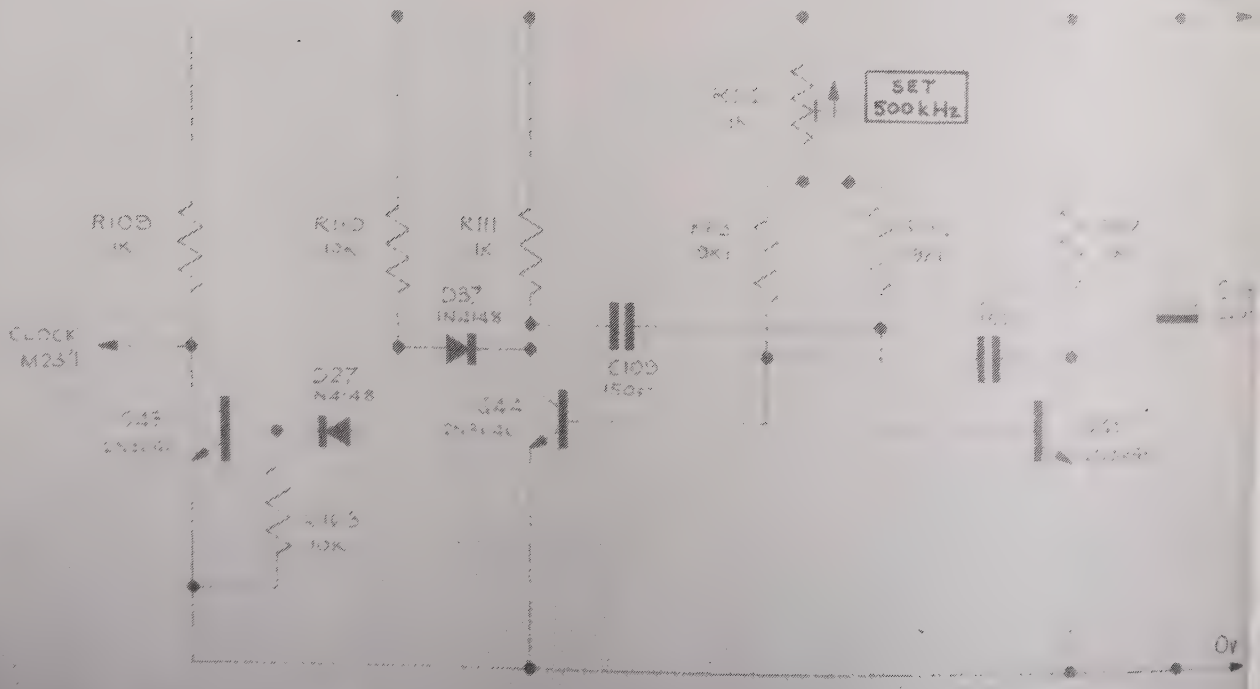
REVISION	DATE		datron ELECTRONICS LTD	
A	25 5 76	R&D M.J.D 28.4.76	1057 A-D SCHEMATIC	
		CHECK		
		PROD	430161	SHEET 3 OF 4

DRAWING No.
430161

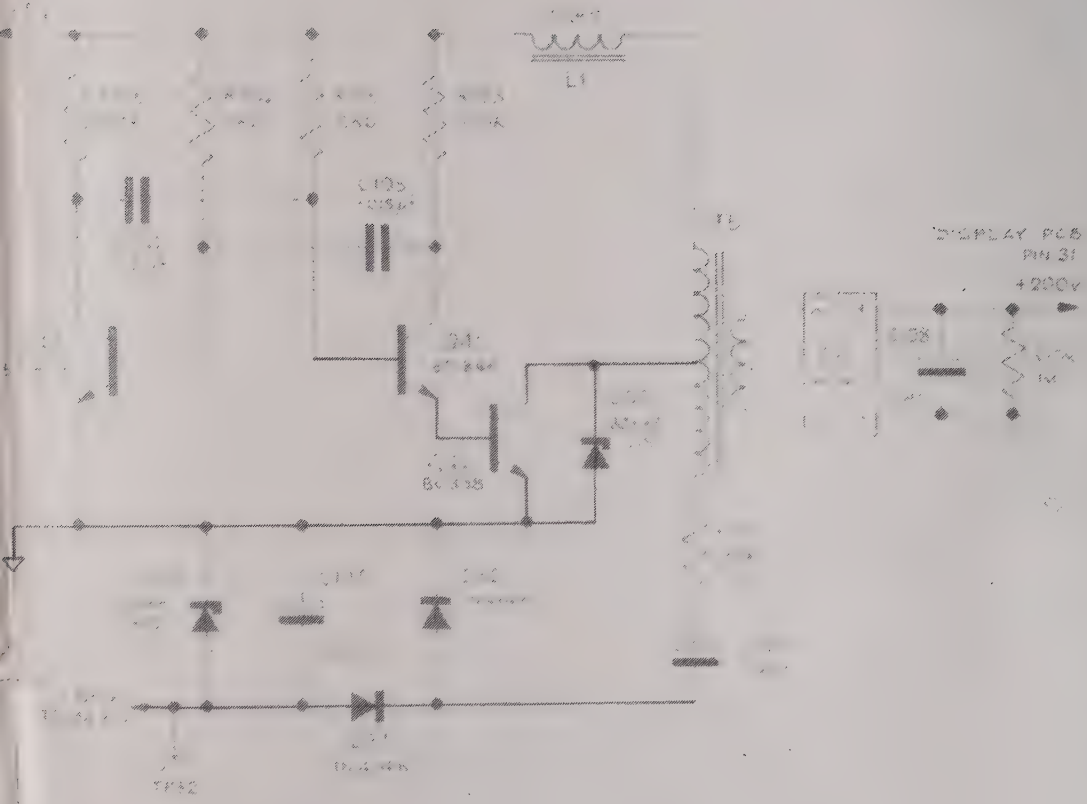
THIRD ANGLE PROJECTION

FIRST USED ON
1057





DRAWN M.J.D.	CHECKED	DIMENSIONS IN MILLIMETRES		MATERIAL
TRACED	APPROVED	SCALE NOT TO BE SCALED		FINISH
DATE 28.4.76	DATE			



datron ELECTRONICS LTD. NORWICH.

DRAWING SIZE A2

TITLE 1057 A-D (SUPPLIES & CLOCK)

DRAWING No. 430161

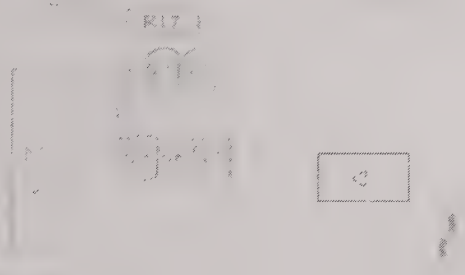
SHEET 4 of 4

DRAWING No
400162

FIRST USED ON
1057

THIRD ANGLE PROJECTION

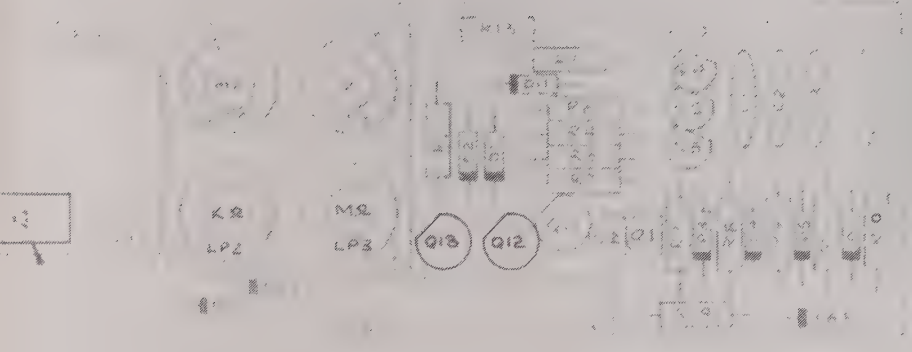
DRAWN IN ACCORDANCE WITH BS 308



27.4.76

NOTES

A	
B	C5 MOUNTED ON TRACK SIDE OF PCB ECO 291 Tue 15.9.81



FIX WITH CYANOCRYLATE ADHESIVE (900001)

BLACK CREPE PAPER TAPE
R KEEP ALIVE PINS IN 2
HTIONS 630030

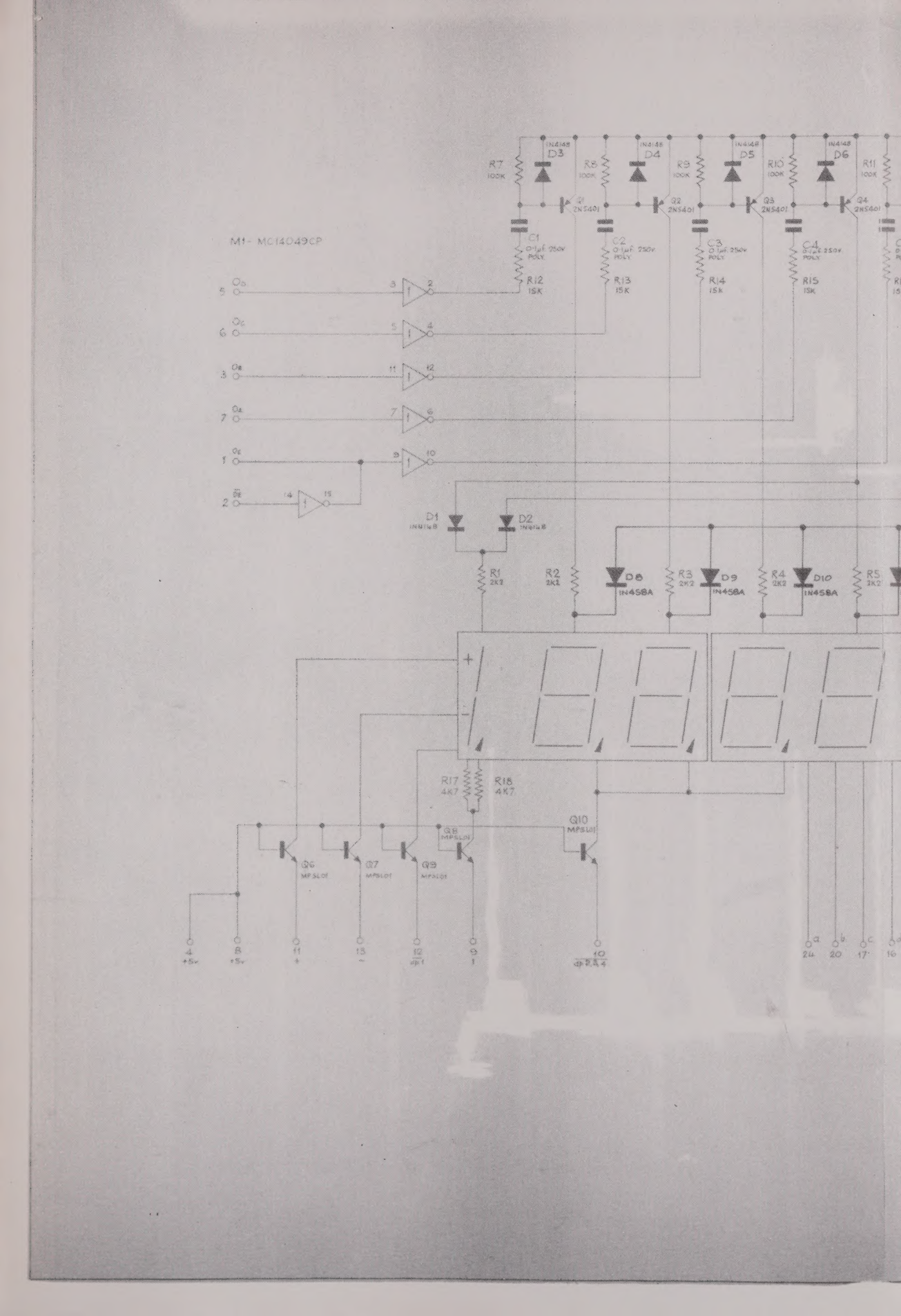
datron ELECTRONICS LTD. NORWICH.

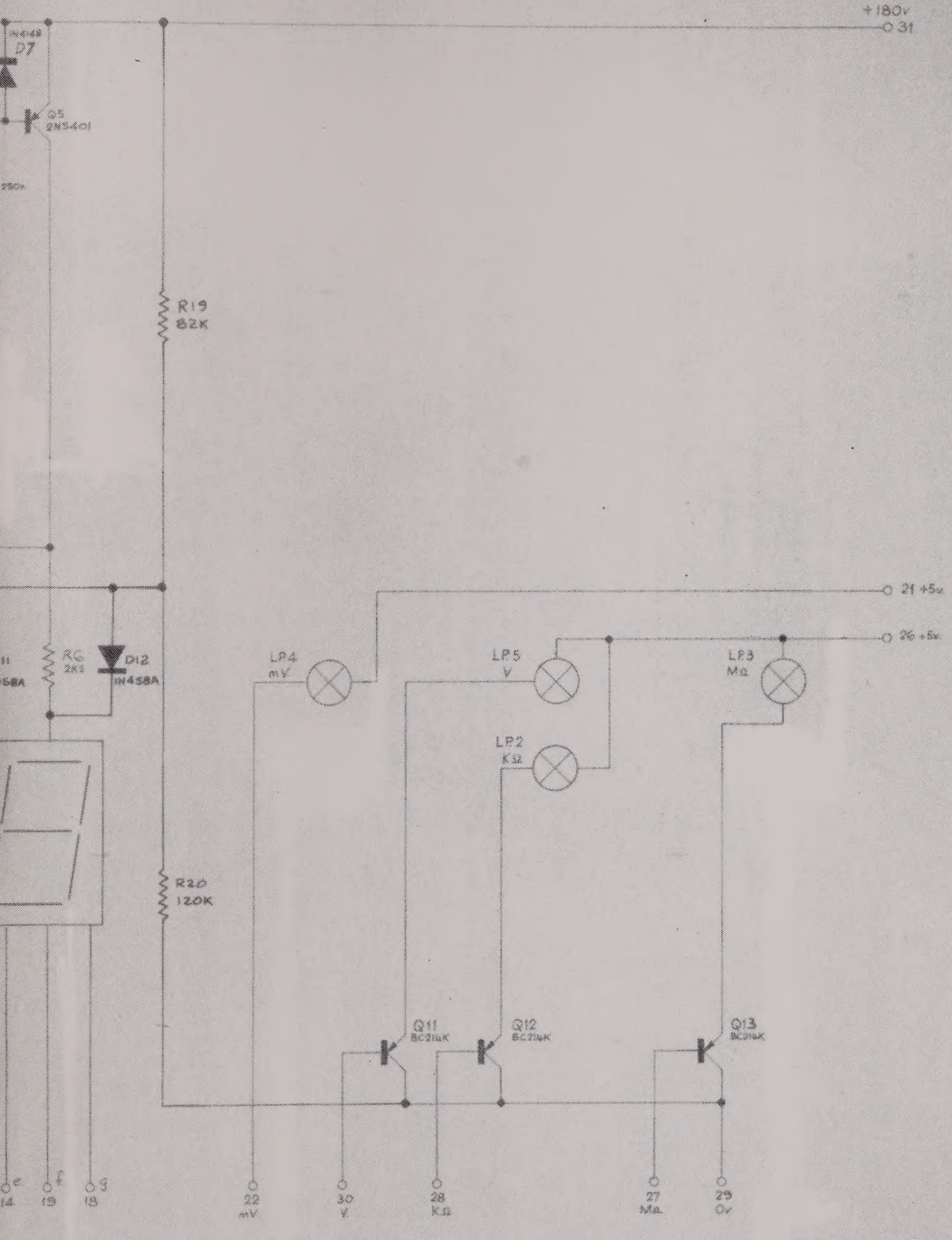
DRAWING SIZE A2

DISPLAY BOARD, 1057

DRAWING No. 400162

SHEET 1 OF 3


M1 - MC14049CP
R7 100K
R8 100K
R9 100K
R10 100K
R11 100K
D3 IN4148
D4 IN4148
D5 IN4148
D6 IN4148
Q1 2N5401
Q2 2N5401
Q3 2N5401
Q4 2N5401
C1 0·1μF 250V POLY
C2 0·1μF 250V POLY
C3 0·1μF 250V POLY
C4 0·1μF 250V POLY
R12 15K
R13 15K
R14 15K
R15 15K
D1 IN4148
D2 IN4148
R1 2K2
R2 2K2
D8 IN4584
R3 2K2
D9 IN4584
R4 2K2
D10 IN4584
R5 2K2
R17 4K7
R18 4K7
Q6 MPSL01
Q7 MPSL01
Q8 MPSL01
Q9 MPSL01
Q10 MPSL01
4 +5v
8 +5v
11 +
13 -
12 dp1
9 1
10 dp2,3,4
a 24
b 20
c 17
16



REVISION	DATE	datron ELECTRONICS LTD		
A		R&D M.J.D. 27.4.76	1057 -3" SPERRY DISPLAY SCHEMATIC	
		CHECK		
		PROD	430162	SHEET 1 OF 1

MP MASTER
MA23499